Energy Labeling, Standards and Building Codes:

A Global Survey and Assessment for Selected Developing Countries

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March 1996

This publication was made possible through support provided by the Office of Energy, Environment, and Technology; Center for Environment; Bureau for Global Programs, Field Support and Research; U.S. Agency for International Development (under the terms of Cooperative Agreement No. PCE-5743-A-00-2057-00). The opinions expressed herein are those of the author and do not necessarily reflect the views of the U.S. Agency for International Development.

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Acknowledgments

This report would not have been possible without the generous assistance of many people. In particular, the author wishes to thank François Abram (ISO), John Newman (IEA), Paul Waide (Ademe, France) and Katy Janda, Mark Levine, Jim McMahon and their colleagues at Lawrence Berkeley National Laboratory for providing supporting information. For both providing information and carefully reviewing draft versions of the report, he thanks John Armstrong (Hagler Bailly Consulting), Lloyd Harrington (Energy Efficient Strategies, Australia) and Stephen Wiel (LBL). And for editorial assistance and report preparation, he thanks Karen Holmes and Bob Price at IIEC. Any errors are, of course, the author's responsibility.

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Executive Summary

Energy efficiency in developing countries plays an important role in global sustainable development. Energy consumption is growing rapidly in these countries, yet energy efficiency remains far below levels in developed countries. Energy efficiency improvements can slow the growth in energy consumption, save consumers and countries money and reduce environmental impacts, especially greenhouse gas emissions. On their own, the market and planned economies of these countries will generally fail to exploit their energy efficiency potential due to the presence of a number of market and bureaucratic barriers. Explicit government policies are necessary to overcome these barriers and achieve cost-effective energy efficiency improvements, along with their associated economic and environmental benefits.

Energy labeling programs, minimum efficiency standards and building energy codes are one class of policies that the International Institute for Energy Conservation (IIEC) and the U.S. Agency for International Development (USAID) promote in developing countries in order to further sustainable economic development. Promoting these policies consistently requires certain information, including the status of these policies in other countries, the record of successes and failures with these policies and the potential impacts of standards and building codes on energy consumption and the environment in the particular country and on export markets of developed countries. This report is intended to serve as a foundation for work by IIEC and USAID in this area.

Status of Labeling Programs, Building Codes and Efficiency Standards

At least 11 countries and the European Union have energy labeling programs. Most programs allow consumers to compare the energy efficiency of similar products and most of these are mandatory and operated by government agencies. Only the United States, Canada and the European Union have endorsement labeling programs that indicate those products which meet a certain minimum level of energy efficiency. These endorsement labeling programs are operated by both government agencies and non-government organizations.

A 1992 survey of 57 countries around the world found thirteen countries without any building energy codes, four countries with codes for residential buildings only, nine countries with codes for non-residential buildings only, and 31 countries with codes for both residential and non-residential buildings.

At least nine countries have efficiency standards for household appliances. Standards in the U.S. and Canada cover the greatest number of products, followed by Switzerland and China. The standards issued by all countries except Japan and Switzerland are mandatory. Japan's standards are voluntary but widely met. Switzerland's standards are target values that must be met to avoid the introduction of mandatory standards.

At least six countries have efficiency standards for industrial and commercial equipment. Again, standards in the U.S. and Canada cover the greatest number of equipment types. No European country has efficiency standards for this class of equipment while Japan has a standard for only one class of product (fluorescent lamps).

Only two countries have efficiency standards for office equipment, Japan and Switzerland. Even then, these standards are voluntary target efficiency values. The Japanese

target values are widely met and the Swiss target values are target values that must be met to avoid the introduction of mandatory standards.

At least five OECD countries and Korea have motor vehicle fuel economy standards. The U.S. has mandatory standards for passenger cars and light truck vehicles while Canada and Korea have mandatory standards for cars. Japan has fuel economy targets for cars. Like target efficiency values for appliances and office equipment, these targets are voluntary but widely met due to the strong cooperation between government and manufacturers. Sweden and Australia have voluntary fuel economy standards for cars.

Assessment of Existing Labeling Programs, Building Codes and Efficiency Standards

In practice, labeling programs, efficiency standards and building codes have had a mixed history of successes and failures. Success stories include refrigerator testing in Brazil and the U.S. Energy Star labeling program appliance efficiency standards. These policy efforts have all met or exceeded their goals in terms of saving energy and money. Failures include harmonized European energy labels, the initial U.S. government energy labels, most building codes, early efficiency standards in Europe and U.S. motor vehicle efficiency standards. These efforts have failed to meet expectations.

A few obvious lessons can be derived from this experience. First, effective implementation is a prerequisite for successful efficiency measures and requires careful consideration of technical, marketing, bureaucratic and political factors. Second, periodic updates of standards are necessary to realize the full benefits of efficiency standards. Obsolete standards fail to provide new energy savings and related benefits. Third, regionally harmonized standards add an extra layer of political and bureaucratic obstacles, yet offer economies of scale at the same time. Fourth, building codes are more difficult to implement than standards.

Impacts from the Introduction or Expansion of Efficiency Standards and Building Codes in Selected Developing Countries

The report presents preliminary estimates of energy savings, carbon emission reductions and export market impacts from the introduction or expansion of efficiency standards or building codes in selected developing countries, including India, Indonesia and the Philippines in Asia and Brazil and Mexico in Latin America. Over a 20-year period, efficiency standards and building codes could save five to ten times as much electricity as is currently consumed in these countries in a single year. Total primary energy savings could amount to between two and four years of current annual consumption. Over 20 years, these energy savings would contribute to reductions in carbon emissions equal to between three and five years of current annual emissions. Finally, these policy measures would expand the global market for energy-efficient products. By the year 2010, increased annual sales of energy-efficient products would total in the hundreds of thousands to millions of units.

1. Introduction

1.1 Energy Efficiency and Sustainable Development

Energy efficiency in developing countries plays an important role in global sustainable development. Energy consumption is growing rapidly in these countries, yet energy efficiency remains far below levels in developed countries. Energy efficiency improvements can slow the growth in energy consumption, save consumers and countries money and reduce environmental impacts, especially greenhouse gas emissions.

On their own, the market and planned economies of these countries will generally fail to exploit their energy efficiency potential due to the presence of a number of market and bureaucratic barriers. These barriers include a) subsidized energy prices that provide little incentive to conserve, b) lack of capital with which to purchase more expensive, energy-efficient products, c) lack of information regarding the long term savings from purchasing energy-efficient products, and d) misplaced incentives, such as building tenants who pay the operating costs of products and buildings bought by landlords. Experience in developed countries has demonstrated that these barriers exist even in the presence of efficient energy prices. Subsidized energy prices exacerbate these barriers by reducing the size and importance of operating costs.

If developing countries are to enjoy the benefits of energy efficiency, explicit government policies will be needed to overcome the identified barriers. First among these policies should be the elimination of subsidies for energy. Subsequently, governments should introduce explicit policies and measures that overcome the information and financial barriers to cost-effective energy efficiency improvements. In this way, these countries can enjoy the economic and environmental benefits of energy efficiency improvements.

1.2 Purpose of Report

The International Institute for Energy Conservation (IIEC) and the U.S. Agency for International Development (USAID) promote energy efficiency in developing countries through education, policy advocacy and private sector development. Energy labeling programs, efficiency standards and building codes are one class of government policy that serves energy efficiency. A full list of energy efficiency policies or measures includes the following:

1. Pricing and metering
2. Taxation
3. Information
   - product testing
   - labeling
   - building energy audits
4. Education and training
5. Financial incentives
6. Efficiency standards and building codes
7. Research, development and demonstration

Whenever IIEC or USAID promote energy labeling, efficiency standards or building codes in a particular country, certain information is consistently required, including a) the status of these policies in other countries, b) the record of successes and failures with these policies and c) the potential impacts of standards and building codes on energy consumption and the environment in the particular country and on export markets of developed countries. This report documents this background information for IIEC and USAID. It is intended to serve as a foundation for further work in this area by the two organizations.

1.3 Report Outline

Section 2 presents the status of energy labeling programs, building codes and efficiency standards around the world. It is based on a review of the journal literature, government reports and conference proceedings as well as interviews with selected experts. Section 3 discusses the successes and failures of these measures and lessons learned, mostly from experience in developed countries. Section 4 preliminary estimates of energy savings, carbon emission reductions and export market impacts from the introduction or expansion of standards and building codes in five developing countries: India, Indonesia and the Philippines in Asia; Brazil and Mexico in Latin America.

1.4 Definitions

The following definitions are used in this report.

Labels: Mandatory or voluntary stickers that are affixed to products or their packaging and that contain information on the energy efficiency or energy consumption of the product.

Mandatory minimum efficiency standards (MMES): Government-mandated standards that define minimum levels of efficiency or maximum levels of energy consumption and that must be met by all products sold in a particular jurisdiction.

High efficiency standards (HES): Voluntary standards that define a high efficiency threshold and that are used to determine eligibility for endorsement labeling programs (such as Energy Star), utility demand-side management programs or other energy conservation initiatives.

Building codes: Mandatory or voluntary minimum engineering specifications for energy efficiency in the construction of new residential and commercial buildings.

2. Status of Labeling Programs, Building Codes and Efficiency Standards Around the World

This section reviews the status and substance of energy labeling programs, building codes and efficiency standards around the world. It is based on a late-1995 review of the journal literature, government reports and conference proceedings as well as selected interviews with experts. While every effort was made to ensure that the information was accurate and up-to-date, time and resource limitations restricted the ability to do so while changing conditions ensure that some information will soon be out of date. Information for developed countries is most complete and up-to-date while that for developing countries is less so.

2.1 Labeling Programs[1]

Labeling programs provide information to consumers regarding the energy efficiency or performance of products. There are two types of labeling programs: comparison and endorsement. Comparison labeling programs provide consumers with information to compare all products within a given category. Endorsement labeling programs identify and endorse a limited number of products that meet a specified high efficiency standards. Labeling programs can be mandatory or voluntary.

This section begins with a summary of labeling programs around the world which is followed by descriptions of individual labeling programs in various countries.

2.1.1 Summary

At least 11 countries and the European Union have energy labeling programs. They are summarized in Table 2-1. Most programs are of the comparison type and most of these are mandatory and operated by government agencies. Only the U.S., Canada and European Union have endorsement labeling programs for energy efficiency and these are operated by both government agencies and non-government organizations.

[1] This section is based largely on Casey-McCabe and Harris.

Table 2-1 Energy Labeling Programs Around the World

Product	U.S.	Can	EU	France	Germany	Japan	Australia	Korea	Philippines	Thailand	Brazil	Mexico
Refrigerators	C/E	C/E	C	C	C	C	C	C		C	C	C
Freezers	C/E	C/E	C			C	C					
Air-con	C						C	C	C	C	C	C
Central air-con	C	E										
Water heaters	C	E					C	C				
Space heaters				C			C	C				
Clothes washers	C/E	C/E	E	C			C					
Clothes dryers	E	C					C					
Dishwashers	C/E	C/E	E		C		C					
Furnaces	C											
Ovens	E				C							
Ranges	E	C		C								
Cookpots	E											
Televisions				C								
Vent. equipment				C								
Lamps	C/E	E						C				
Ballasts	C	E						C				
Windows	C/E	E										
Doors	C											
Skylights	C											
Showerheads	C	E										
Faucets	C	E										
Automobiles	C							C				
Office equipment	E	E										
Motors		E						C/E				
Boilers				C				C				

Note: C = comparison labeling program, E = endorsement labeling program. The table does not include some products covered by endorsement labels in Canada. See Table 2-4 for a complete list of products covered by endorsement labels in Canada.

2.1.2 United States

The United States has six energy labeling programs in total, the most of any country. Two are mandatory comparison programs, two are voluntary comparison programs and two are voluntary endorsement programs. The two mandatory comparison programs, Energy Guide and automobile fuel economy labels, were established by law in the 1970s.

The Energy Policy and Conservation Act of 1975 established the Energy Guide program and delegated responsibility for its implementation to the Federal Trade Commission (FTC). It requires certain household appliances and equipment sold in the U.S. to carry a prescribed label indicating the energy performance or annual energy consumption of the product. Manufacturers test their own products and produce the labels, while manufacturer associations oversee the program and conduct spot checks of ratings to assure accuracy. The FTC acts as the final arbitrator of disputes.

The first Energy Guide labeling rule became effective in 1980 for major household appliances. Other products were subsequently added by legislation. In 1994 the FTC changed the label design to make them easier to understand. The labeling requirement for automobile fuel economy was enacted about the same time. Table 2-2 lists the products covered by mandatory energy efficiency labeling rules in the United States.

Table 2-2 Products Covered by Energy Labeling Rules in the United States

Product	Effective Date of Initial Labeling Rule
Refrigerator and refrigerator-freezers	1980
Freezers	1980
Water Heaters	1980
Clothes Washers	1980
Dishwashers	1980
Room Air-Conditioners	1980
Furnaces	1980
Automobiles	1980
Central Air-Conditioners and Heat Pumps	1987
Fluorescent Lamp Ballasts	1988
Showerheads	1995
Faucets	1995
Fluorescent Lamps	1995
Compact Fluorescent Lamps	1995
Incandescent Lamps	1995

Source: Federal Trade Commission

There are two voluntary comparison labeling programs in the U.S. that are operated by non-government organizations. The National Fenestration Rating Council (NFRC), a coalition of fenestration companies, governments, utilities and consumer groups, operates a comparison labeling program for windows, doors, skylights and other fenestration products. Established in 1989, the NFRC developed a uniform performance rating system for fenestration products and a labeling scheme modeled after the U.S. government Energy Guide program. Manufacturers pay a fee to have their products evaluated and tested by NFRC accredited laboratories. Since 1993, the NFRC has certified and labeled over 12,000 products made by over 160 manufacturers. NFRC's work is being recognized nationally and internationally. Their procedure for determining the emitance of glazing materials has been adopted by the American Society for Testing Materials (ASTM). In addition, the International Organization for Standardization (ISO) is working with the NFRC to ensure that their related standards will be compatible with NFRC procedures.

The other voluntary comparison labeling program is operated by Scientific Certification Systems (SCS), a multi-disciplinary independent scientific organization working to promote environmental sustainability. SCS uses an "Environmental Report Card" to provide consumers with detailed information about a product's life-cycle environmental impact, including energy consumption. SCS evaluation services are provided on a fee-for-service basis but payment of the fee does not guarantee SCS certification.

Two voluntary endorsement labeling programs in the United States are operated by the U.S. government and a non-profit organization, respectively. The U.S. Environmental Protection Agency (EPA) operates the Energy Star program. Established in 1992, Energy Star is a voluntary labeling program for energy-efficient office equipment and distribution transformers. Initially, the program focused on personal computers, monitors and printers. The program has since added fax machines (1994), copiers (1995) and distribution transformers (1996). Products complying with the Energy Star high efficiency standards are eligible to use the Energy Star logo on the product shipping box or on the device itself. Product testing is left to individual manufacturers while the EPA investigates any complaints from competing manufacturers or users about improperly labeled products. The EPA is in the process of negotiating agreements with government agencies and industry groups in Europe and Japan on a common, internationally recognized set of Energy Star high efficiency standards.

Table 2-3 lists the high efficiency standards in the Energy Star program. Since most office equipment spend the majority of their operating time in standby mode, the Energy Star standards are written for this mode. About half of all desktop and deskside personal computers currently sold in the U.S. comply with these standards.

Table 2-3 High Efficiency Standards in the U.S. Energy Star Program

Product	Max. Energy Consumption (Watts)	Standby/Off Mode Default Time (Minutes)
Personal Computers (standby)	30	n/a
Monitors (standby)	30	n/a
Printers (standby)		
1-7 PPM	15	15
8-14 PPM	30	30
color and ≥ 15 PPM	45	60
Fax Machines		
1-7 PPM	15	5
8-14 PPM	30	5
color and ≥ 15 PPM	45	15
Copiers (effective 1997)		
CPM ≤ 20 (off)	5	
CPM ≤ 20 (standby)	n/a	30
20 < CPM ≤ 44 (standby)	5 + 3.85CPM	
20 < CPM ≤ 44 (off)	10	60
CPM > 44 (standby)	5 + 3.85CPM	
CPM > 44 (off)	15	90

Note: PPM = pages per minute, CPM = copies per minute. Source: EPA

The U.S. Energy Star program has been highly successful in attracting widespread participation by manufacturers, especially in the personal computer and printer industries. Two years after the program's initiation, over 50 percent of personal computers and 80 percent of printers were compliant with Energy Star high efficiency standards. Average power requirements of U.S. personal computers in active mode have fallen from 75 or 80 watts a few years ago to 35 or 45 watts today, largely due to the Energy Star program.

The second endorsement labeling program is operated by Green Seal, a non-profit organization dedicated to product labeling and consumer education. Green Seal's goal is to offer unbiased advice to consumers regarding the environmental impact of products. Green Seal is not managed or supported by government agencies or product manufacturers, a factor that it considers crucial for its credibility with consumers. To date, Green Seal has issued environmental impact and/or high efficiency standards for 52 product categories and Green Seal labels for 112 products. High efficiency energy standards have been established for compact fluorescent lamps, windows, dishwashers, clothes washers and dryers, refrigerators and freezers, cookpots, ovens and ranges. The standards are set to identify models that are in the top 20 percent of the market in terms of energy efficiency. Manufacturers interested in applying for the Green Seal label pay a product evaluation fee to have their product test by a Green Seal accredited laboratory.

2.1.3 Canada

Canada has both comparison and endorsement energy labeling programs. In 1978, the Canadian government established the EnerGuide comparison labeling program. By law, an EnerGuide label must be affixed to every kitchen range, refrigerator, freezer, dishwasher, clothes washer and clothes dryer sold in Canada. The original label contained information on the monthly energy consumption of the appliance only. In 1992 it was revised to include a scale of energy performance which enables consumers to compare the model with similar products.

Canada's voluntary endorsement labeling program, Power Smart, was established in 1989 as a demand-side management effort by a public utility. Now owned by seven Canadian utilities, Power Smart is an international membership organization comprised of gas and electric utilities and government agencies that markets the Power Smart label internationally. Interested manufacturers submit an application for the product label and, if accepted, pay a $500 fee to Power Smart for each product line covered by the label. As of the middle of 1994, over 1,900 products were certified by Power Smart in more than 30 product categories. Table 2-4 lists the product categories covered by the Power Smart labeling program.

Table 2-4 Product Categories Covered by the Power Smart Labeling Program

Clothes Washers	Low Wattage House Signs
Dishwashers	Motion Detectors
Refrigerators/Freezers	Photocells
Water Heaters	Faucet Aerators
Solar Water Heaters	Showerheads
Water Heater Tank Insulating Blankets	Thermostats
Air-tight Electrical Boxes	Timers
Caulking Materials	Pipe Wrap
Fireplace Flue Seal	Heat Pumps
Foam Gaskets	Five Watt and Mini Holiday Lights
House Wrap	Compact Fluorescent Luminaires
Insulation	Compact Fluorescent Lamps
Weather-stripping	Electronic Ballasts
Electric motors	Halogen Lamps and Luminaires
Variable Speed Drives	Spa Covers
Block Heater Controllers	Printers
Dimmer Switches	Retrofit Devices
Low Wattage Exit Signs	Windows

Source: Power Smart Inc.

Power Smart does not have fixed high efficiency standards like Energy Star. Instead, the Power Smart performance criteria are set to capture roughly the top 20 percent of energy-efficient products in terms of sales. This target group varies by product from 3 to 40 percent. This approach reflects Power Smart's goal of moving the market towards energy efficiency rather than adhering to a set of high efficiency standards.

2.1.4 Europe

Western Europe has both comparison and endorsement labeling programs. The mandatory comparison labeling program was established in 1992 by a directive of the European Community Council, the legislative body of the European Union (EU). The directive called for labeling and standardized product information on the energy consumption of household appliances sold throughout the EU. The first set of appliance labeling requirements took effect in early 1995 for refrigerator-freezers and freezers.

The EU also established a voluntary endorsement labeling program in 1992. The Ecolabel program is based on a life-cycle assessment of a product's environmental impact, including energy consumption. To date, the program has issued environmental and high efficiency energy standards for clothes washers and dishwashers.

In 1976, France introduced mandatory comparison labeling of heating appliances, boilers, refrigerators, clothes washers, televisions, ranges and ventilation equipment. However, the labeling requirements were not rigorously enforced. Also since 1976, Germany has operated a voluntary comparison labeling program for ovens, refrigerators and dishwashers.

Some eastern European countries are developing energy efficiency standards and labeling programs, including the Czech Republic, Poland and Romania. To date, only the Czech Republic has developed labels, for refrigerators and clothes washers.

2.1.5 Japan

Japan has a mandatory comparison labeling program for refrigerator-freezers and freezers. Japan is considering labels for air-conditioners, color televisions, washing machines, microwave ovens, clothes dryers, space and water heaters and lighting equipment (Turiel et al, 1995).

2.1.6 Australia

Australia has two comparison programs, one mandatory and one voluntary. The government has operated a mandatory comparison labeling program for electric household appliances since 1987. Appliances requiring energy performance labels include refrigerator-freezers, freezers, air-conditioners, dishwashers, clothes washers and clothes dryers. The Australian Gas Association (AGA), an industry association, has operated a voluntary comparison labeling program for gas-fired space and water heaters since the early 1980s. The AGA's labels are currently modeled after the government's labels. An extension of these programs is being examined for gas and electric cooking appliances and for electric storage, solar and heat pump water heating systems. New Zealand is also considering the introduction of an appliance labeling program modeled after Australia (Harrington, 1994).

2.1.7 Asia (excluding Japan)

Energy labeling programs exist in Thailand, the Philippines and Korea. In Thailand, the Electrical Generating Authority of Thailand (EGAT) operates voluntary labeling programs for refrigerators and residential air-conditioners. The refrigerator labeling program began as a pilot program covering a limited number of models in 1994 and will be expanded to cover all models in 1996. The air-conditioner labeling program was introduced in 1995. EGAT's demand-side management office is considering offering rebates or prizes to customers purchasing refrigerators and air-conditioners that carry the highest efficiency label. The government has announced plans to expand the labeling program to cover fans, motors and incandescent and fluorescent lamps.

Mandatory comparison labeling program are operated by the governments of the Philippines and Korea. In the Philippines, only room air-conditioners must carry labels. In Korea, various products, listed in Table 2-5, must carry them. Some products must have labels that report absolute energy efficiency while others must have labels that report relative efficiency based on other models. Manufacturers must have their products tested by authorized testing agencies and report test results to the Korea Energy Management Corporation (KEMCO), the government agency responsible for the program.

Table 2-5 Products Covered by Energy Labeling Rules in Korea

Labels Must Indicate Absolute Energy Efficiency	Labels Must Indicate Relative Energy Efficiency
Steel, cast iron and water boilers	Refrigerators
Oil heaters	Air-conditioners
Instantaneous water heaters	Incandescent and fluorescent lamps
Lighting equipment	Fluorescent lamp ballasts
Automobiles	Automobiles
Electric Motors	

The Korean government also operates an endorsement labeling program for high efficiency motors that was introduced in late 1992. Korean standard KS C 4202 specifies the high efficiency standards for 3 phase 4 pole (1,800 rpm) induction motors with a power rating of less than 37 kW (50 hp). Manufacturers that meet this requirement are eligible to put the Korean high efficiency label on their motor at the point of sale.

2.1.8 Latin America

Comparison energy labels are required on refrigerators and air-conditioners in Brazil and Mexico. Brazil is considering expanding its program to cover lamps, lamp ballasts and motors. Mexico's labeling program is modeled after the U.S. and EU schemes (Turiel et al, 1995).

2.2 Building Codes[2]

The building sector consumes roughly one-third of the final energy used in most countries. This sector absorbs an even more significant share of electricity use or demand. In developed countries, buildings account for 57 percent of electricity use: 31 percent in the residential sector and 26 percent in the commercial sector. In less-developed countries, buildings account for 38 percent of electricity consumption. Electricity use in this sector has been growing by 10 percent per year over the last 15 years. As people in less-developed countries raise their standards of living and services, building electricity use is expected to continue to increase, especially in the commercial sector.

Building energy codes can help to reduce the growth of energy consumption by ensuring that cost-effective energy efficiency opportunities are incorporated into new buildings. This is especially true in less-developed countries, where the number of new buildings is growing rapidly.

2.2.1 Summary

A 1992 survey of 57 countries around the world found thirteen countries without any building energy codes, four countries with codes for residential buildings only, nine countries with codes for non-residential buildings only, and 31 countries with codes for both residential and non-residential buildings. Results are summarized in Table 2-6 below. Three of the 11

[2] This section is based on Janda and Busch, 1994.

voluntary codes are mixed, meaning that they are voluntary guidelines but mandatory in limited regions or for specific building types. Five more countries have proposed but not yet adopted building energy codes.

Table 2-6 Status and Coverage of Building Energy Codes in 57 Countries

Mandatory (28)	**Voluntary/Mixed** (11)	**Proposed** (5)	**No Codes** (13)
Belgium	*Jamaica (M)*	*Hong Kong*	Argentina
Greece	*Malaysia*	*Indonesia*	Bangladesh
Ireland	*Philippines*	Australia	Botswana
Israel	*South Africa*	Colombia	Brazil
Hungary	Canada (M)	Cote D'Ivoire	Costa Rica
Singapore	Finland		Djibouti
Chile	Pakistan		India
China	Romania		Iran
Czechoslovakia	Saudi Arabia		Mexico
Denmark	(former) USSR		Nicaragua
France	United States (M)		Paraguay
Germany			Uruguay
Italy			Venezuela
Japan			
Korea			
Kuwait			
Netherlands			
New Zealand			
Norway			
Poland			
Portugal			
Spain			
Sweden			
Switzerland			
Thailand			
Turkey			
United Kingdom			
Yugoslavia			

Note: **Bold** = residential buildings only, *Italics* = Non-residential buildings only, Regular = Both residential and non-residential buildings. Source: Janda and Busch, 1994.

There are too many countries with building codes to summarize their individual measures here. However, the source journal article for this section, listed in Section 6, provides a good summary and discussion of these codes.

Many countries modeled their building energy codes on those in other countries. The most often-cited reference building codes were those issued by the American Society of Heating, Refrigeration and Air-Conditioning Engineers: ASHRAE 90.1-1989 and 90.2-1989 for non-residential and residential buildings, respectively. Eleven countries used the ASHRAE standards to develop their building energy codes, including China, Hong Kong, Malaysia, Pakistan, the

Philippines, Singapore, South Korea and Thailand. Most residential building energy codes in the United States are based on the Model Energy Code issued by the Council of American Building Officials (CABO).

2.2.2 United States

Building energy codes exist in the United States at both the federal and state level. The federal Department of Energy (DOE) issues mandatory building energy codes for federal government residential and non-residential buildings. These codes do not however, apply to non-federal government buildings, the majority of the building stock. That mandate is left to state governments.

An estimated 46 states have some type of building energy code. However, residential codes in 30 states and non-residential codes in 40 states are considered to be out-of-date by the U.S. Alliance to Save Energy, a non-profit organization that tracks building codes across the country. In addition, many U.S. cities have their own building energy codes.

2.3 Appliance and Equipment Standards

Rapid economic growth in developing countries is driving rapid growth in the number of household appliances and commercial and industrial equipment, which in turn is straining the energy supply systems of these countries and contributing to growing environmental impacts. Mandatory minimum efficiency standards (MMES) can reduce the burden of this growth by establishing a minimum level of efficiency among new products.

2.3.1 Household Appliances[3]

In most countries, residential electricity consumption typically ranges from 20 to 40 percent of total electricity consumption. This energy is used by a variety of appliances providing space and water heating, food and space cooling, lighting and other end-uses.

This section begins with a summary of appliance standards around the world which is followed by descriptions of individual standards in various countries.

2.3.1.1 Summary

At least nine countries have mandatory minimum efficiency standards (MMES) for household appliances. The U.S. and Canada have the most, followed by Switzerland and China. The standards issued by all countries except Japan and Switzerland are mandatory. Japan's

[3] This section is based largely on Turiel, Kollar and McMahon, 1995.

standards are voluntary but widely met. Switzerland's standards are target values that must be met to avoid the introduction of mandatory standards by the government.

Table 2-7 Household Appliances Covered by Efficiency Standards Around the World

Product	U.S.	Can	Japan	Switz	China	Korea	Phil.	Taiwan	Mexico
Refrigerators	Y	Y		Y	Y	Y		Y	Y
Freezers	Y	Y		Y					
Direct Htg. Equip.	Y								
Ranges/Ovens	Y	Y		Y				Y	
Room AC	Y	Y	Y		Y	Y	Y	Y	Y
Central AC	Y	Y			Y	Y		Y	
Water Heaters	Y	Y						Y	
Heat Pumps	Y	Y	Y						
Dishwashers	Y	Y		Y					
Clothes Washers	Y	Y		Y	Y				
Clothes Dryers	Y	Y		Y				Y	
Televisions			Y	Y					
VCRs				Y					
Furnaces	Y	Y		Y					
Fans					Y			Y	
Rice Cookers					Y				
Irons					Y				
Showerheads	Y								
Faucets	Y								

Products not covered by this list but for which standards are applicable include general service incandescent lamps, portable lighting fixtures and windows.

2.3.1.2 United States

Mandatory minimum efficiency standards on household appliances in the United States are issued under the National Appliance Energy Conservation Act (NAECA) of 1987 and the Energy Policy Act (EPACT) of 1992. The acts charge the Department of Energy (DOE) with implementation of standards and require certain products sold in the U.S. to meet specified levels of energy efficiency or energy consumption by certain dates. Manufacturers are responsible for testing their own products but are subject to spot checks by the DOE.

The first efficiency standards came into effect on January 1, 1988. These were minor requirements for clothes washers, clothes dryers and dishwashers that were already satisfied by most models on the market. The first substantial efficiency standards came into effect on January 1, 1990. Standards on other products followed. Table 2-8 lists the products covered by standards under NAECA and EPACT (showerheads and faucets) and the effective dates of their initial standards and subsequent updates. The table ignores the minor standards issued in 1988. These standards are estimated to cover 96 percent of residential energy use.

Table 2-8 Household Appliances Covered by Efficiency Standards in the U.S.

Product	Effective Date of Initial Standard, *Update*
Refrigerators and Refrigerator-Freezers	1990, *1993*
Freezers	1990, *1993*
Direct Heating Equipment	1990
Kitchen Ranges and Ovens	1990
Room Air-Conditioners	1990
Water Heaters	1990
Pool Heaters	1990
Furnaces	1992
Central Air-Conditioners and Heat Pumps	1992-93
Dishwashers	1994
Clothes Washers	1994
Clothes Dryers	1994
Showerheads	1994
Faucets	1994

NAECA instructed the DOE to consider seven factors in determining appliance efficiency standards:

1. The economic impact of the standard on manufacturers and consumers of the products;
2. The net savings in operating costs (including incremental installation and maintenance costs) throughout the estimated average life of the covered product compared to the increase in price;
3. The total amount of projected energy savings;
4. Any lessening of the utility of the covered products;
5. The impact of any lessening of competition due to the elimination of models and/or manufacturers from the market;
6. The need for national energy conservation; and
7. Other factors that DOE considers relevant.

If DOE finds that the additional cost to the consumer of purchasing a product complying with an efficiency standard will be less than three times the value of the energy savings during the first year, as calculated using the appropriate test procedure, the standard is deemed economically justified. This is equivalent to a simple payback of less than three years. Unless any of the other factors take precedence, energy-efficiency improvements with payback periods of less than three years are incorporated into standards. In some cases, energy-efficiency improvements with payback periods greater than three years are incorporated into standards.

The following tables list U.S. mandatory minimum efficiency standards on household appliances and their associated test procedures. The test procedures are listed in the Code of Federal Regulations (CFR) but reference other test procedures issued by testing and certification organizations. Standards for kitchen ranges and ovens and pool heaters are not listed in the tables since they simply require that products equipped with an electrical supply cord not be equipped with a constant burning pilot. The pool heater standard requires a thermal efficiency of no less than 78 percent.

Table 2-9 U.S. Efficiency Standards for Refrigerators and Freezers

Product Class	Max Energy Consumption (kWh/yr)
Manual Defrost Refrigerator and Refrigerator-Freezer	299 + 0.046AV
Partial Auto-Defrost Refrigerator-Freezer	398 + 0.364AV
Top-Mount Auto-Defrost Refrigerator-Freezer	355 + 0.560AV
Top-Mount Auto-Defrost with Through-the-Door Features	391 + 0.616AV
Side-Mount Auto-Defrost Refrigerator-Freezer	501 + 0.413AV
Side-Mount Auto-Defrost with Through-the-Door Features	527 + 0.571AV
Bottom-Mount Auto-Defrost Refrigerator-Freezer	367 + 0.578AV
Upright Manual-Defrost Freezer	264 + 0.361AV
Upright Auto-Defrost Freezer	391 + 0.522AV
Chest Freezer	160 + 0.385AV

Note: Effective 1993. AV means adjusted volume, in liters. For refrigerator-freezers, AV = refrigerator volume + (1.63 x freezer volume). For freezers, AV = (1.73 x freezer volume). Test procedure is in CFR 10 Part 430 and references AHAM HRF-1-1979 (ANSI B38.1-1970). Source: Turiel, Kollar and McMahon, 1995.

Table 2-10 U.S. Efficiency Standards for Direct Heating Equipment

Product Class (all Natural Gas)	Size	Minimum AFUE (percent)
Wall Fan	Btu/hr ≤ 42,000	73
	Btu/hr > 42,000	74
Wall Gravity	Btu/hr ≤ 10,000	59
	10,000 < Btu/hr ≤ 12,000	60
	12,000 < Btu/hr ≤ 15,000	61
	15,000 < Btu/hr ≤ 19,000	62
	19,000 < Btu/hr ≤ 27,000	63
	27,000 < Btu/hr ≤ 46,000	64
	Btu/hr > 46,000	65
Floor	Btu/hr ≤ 37,000	56
	Btu/hr > 37,000	57
Room	Btu/hr ≤ 18,000	57
	18,000 < Btu/hr ≤ 20,000	58
	20,000 < Btu/hr ≤ 27,000	63
	27,000 < Btu/hr ≤ 46,000	64
	Btu/hr > 46,000	65

Note: Effective 1990. AFUE means Annual Fuel Utilization Efficiency. Test procedure is in CFR 10 Part 430 and references ANSI Z21.49-1975. Source: CFR.

Table 2-11 U.S. Efficiency Standards for Room Air-Conditioners

Product Class	Minimum EER (BTU/Wh)
Without reverse cycle and with louvered sides	
< 6,000 BTU	8.0
6,000 to 7,999 BTU	8.5
8,000 to 13,999 BTU	9.0
14,000 to 19,999 BTU	8.8
> 20,000 BTU	8.2
Without reverse cycle and without louvered sides	
< 6,000 BTU	8.0
6,000 to 7,999 BTU	8.5
8,000 to 13,999 BTU	8.5
14,000 to 19,999 BTU	8.5
> 20,000 BTU	8.2
With reverse cycle and with louvered sides	8.5
With reverse cycle and without louvered sides	8.0

Note: Effective 1990. EER = Energy Efficiency Ratio. Test procedure is in CFR 10 Part 430 and references ANSI Z234.1-1972 and ASHRAE Standard 16-69. Source: CFR

Table 2-12 U.S. Efficiency Standards for Central Air-Conditioners and Heat Pumps

Product Class	Minimum SEER (BTU/Wh)	Minimum HSPF (BTU/Wh)
Split System	10.0	6.8
Single-package	9.7	6.6

Note: Effective 1992-93. SEER = seasonal energy efficiency ratio. HSPF = heating seasonal performance factor. Test procedure is in CFR 10 Part 430 and references ASHRAE Standard 37-78 and ARI Standards 210-79, 240-77 and 320-76. The SEER is defined in the test procedures as the total cooling in BTU's during the normal annual usage period for cooling divided by the total electric energy input in Watt-hours during the same period. Several test points must be measured to calculate SEER. HSPF is defined as the total heating output in BTU's of a heat pump during its normal annual usage divided by the total electric energy input in Watt-hours Source: CFR.

Table 2-13 U.S. Efficiency Standards for Water Heaters

Product Class	Minimum Energy Factor
Natural Gas	0.62 - 0.0005V
Oil	0.59 - 0.0005V
Electric	0.93 - 0.00035V

Note: Effective 1990 Energy factor is a measure of appliance efficiency. V = rated storage volume in liters. Test procedure is in CFR 10 Part-430. Source: Turiel, Kollar and McMahon, 1995.

Table 2-14 U.S. Efficiency Standards for Furnaces

Product Class	Minimum AFUE (percent)
Furnaces (excluding classes noted below)	78
Mobile Home Furnaces	75
Small Furnaces (other than for mobile homes) with an input rate < 45,000 Btu/hr	78
Boilers (excluding gas steam)	80
Natural Gas Steam Boilers	75

Note: Effective 1990-92. Test procedure is in CFR 10 Part 430 and references ANSI/ASHRAE 103-82. Source: CFR.

Table 2-15 U.S. Efficiency Standards for Dishwashers, Clothes Washers and Dryers

Product Class	Minimum Energy Factor
Compact Dishwasher (< 56 cm width)	0.62 cycles/kWh
Standard Dishwasher (> 56 cm width)	0.46 cycles/kWh
Top-loading Compact Clothes Washer (< 45.7 liters)	25.7 liters/kWh/cycle
Top-loading Standard Clothes Washer (> 45.7 liters)	33.7 liters/kWh/cycle
Electric Compact Clothes Dryer, 120 V (< 125 liters)	1.42 kg/kWh
Electric Compact Clothes Dryer, 240 V (< 125 liters)	1.32 kg/kWh
Electric Standard Clothes Dryer (> 125 liters)	1.37 kg/kWh
Natural Gas Clothes Dryer	1.21 kg/kWh

Note: Effective 1994. Test procedures are in CFR 10 Part 430 and reference AHAM DW-1 for dishwashers, AHAM HWL-1 and HWL-2EC and ANSI Z224.1-1971 for clothes washers and AHAM HLD-1 and HLD-2EC for clothes dryers. Source: Turiel, Kollar and McMahon, 1995.

Table 2-16 U.S. Efficiency Standards for Showerheads and Faucets

Product	Max. Water Use (gallons per minute)
Showerheads	2.5
Faucets	2.5

Note: Effective 1994. At a flowing water pressure of 80 pounds per square inch. Test procedure is in CFR 10 Part 430 and references ASME/ANSI A112 18.1M-1989. Source: CFR.

2.3.1.3 Canada

Under the Federal Energy Efficiency Act of 1993, mandatory minimum efficiency standards on household appliances became effective in February 1995. The act delegates responsibility for the implementation of standards to Natural Resources Canada (NRCan), a federal government department, and requires certain products to meet specified levels of energy efficiency or energy consumption by certain dates. The standards apply to products that are imported into Canada or that cross provincial boundaries, but do not apply to products manufactured and sold in the same province. The exclusion of the latter products is due to the

division of power between federal and provincial governments in Canada. Also, the federal legislation does not preempt provincial legislation. Some provinces have more stringent standards than the federal government and products sold in these provinces have to meet the more stringent provincial standard. Manufacturers must receive third-party verification of their products' energy performance from certified testing facilities.

The first standards came into effect in February, 1995 and covered 22 products. Standards are being developed for 18 other products. Table 2-17 lists the household appliances covered by federal efficiency standards in Canada.

Table 2-17 Household Appliances Covered by Efficiency Standards in Canada

Refrigerators and Refrigerator-Freezers
Freezers
Kitchen Ranges
Water Heaters
Furnaces
Heat Pumps
Room Air-Conditioners
Central Air-Conditioners
Dishwashers
Clothes Washers
Clothes Dryers

Canada adopted the U.S. standards for refrigerators, freezers and room air-conditioners. The following tables list the Canadian efficiency standards for other household appliances.

Table 2-18 Canadian Efficiency Standards for Electric Kitchen Ranges

Product Class	Max. Energy Consumption (kWh/month)
Freestanding or built-in appliances with one or more surface elements and one or more ovens	14.3 + 0.93V
Built-in or wall-mounted appliances with one or more ovens and no surface elements	38
Counter-mounted appliances with one or more surface elements and no ovens with conventional cook top	34
Counter-mounted appliances with one or more surface elements and no ovens with modular cook top	43

Note. Effective 1995. V = volume of the oven in liters. Test procedure is CSA-C358-M89. Source: NRCan, 1995

Natural gas ranges must have no continuously burning pilot light if the product has a cord set.

Table 2-19 Canadian Efficiency Standards for Water Heaters

Product Class	Unit of Measure	Standard	Test Procedure
Electric 50 - 270 liters 271 - 450 liters	Max. Standby Loss (Watts) Max. Standby Loss (Watts)	61 + 0.20V 0.472V - 12.5	CSA-C191.1-M90
Natural Gas 76 - 380 liters and input rating ≤ 21.97 kW (75,000 BTU/hr)	Min. Energy Factor	0.62 - 0.0005V	CSA-4.1-M85
Oil < 190 liters and input rating ≤ 30.5 kW (0.75 USGPH)	Min. Energy Factor	0.59 - 0.0005V	CSA-B211-M90

Note: Effective 1995. V = rated storage capacity in liters. Source: NRCan, 1995.

Table 2-20 Canadian Efficiency Standards for Furnaces

Product Class	Min. AFUE	Min. Thermal Efficiency	Min. Seasonal Energy Utilization Efficiency
Natural Gas			
≤ 225,000 BTU/hr, single-phase current.	78%	n/a	n/a
≤ 225,000 BTU/hr, three-phase current	78%	80%	n/a
225,000 < BTU/hr ≤ 400,000	n/a	80%	n/a
Oil			
< 225,000 BTU/hr	n/a.	n/a	78%

Note: Effective 1995. AFUE = annual fuel utilization efficiency. Test procedures are CGA-2.3-M93 (ANSI Z21.47-1993) for natural gas furnaces and CSA-B212-M93 for oil furnaces. Source: NRCan, 1995.

Table 2-21 Canadian Efficiency Standards for Dishwashers, Clothes Washers and Dryers

Product Class	Standard	Test Procedure
All Dishwashers	Max 55.1 + 1.57V kWh/month	CSA-C373-92
Compact Dishwashers (< 56 cm width)	Min 0.62 cycles/kWh	"
Standard Dishwashers (> 56 cm width)	Min 0.46 cycles/kWh	"
All Clothes Washers	Max 30.5 + 1.5V kWh/month	CSA-C360-M92
Compact Clothes Washers (< 45.7 liters)	Min 25.48 liters/kWh/cycle	"
Standard Clothes Washers (> 45.7 liters)	Min 33.41 liters/kWh/cycle	"
All Electric Clothes Dryers	Max 59 + 0.3V kWh/month	CSA-C361-92
Electric Compact Clothes Dryers, 120 V (< 125 liters)	Min 1.42 kg/kWh	"
Electric Compact Clothes Dryers, 240 V (< 125 liters)	Min 1.31 kg/kWh	"
Electric Standard Clothes Dryers (> 125 liters)	Min 1.36 kg/kWh	"

Note: Effective 1995. V = volume of clothes washer tub, volume of clothes dryer drum or volume of hot water used in dishwasher, in liters. Source: NRCan, 1995.

Table 2-22 Canadian Efficiency Standards for Central Air-Conditioners and Heat Pumps

Product Class	Min. SEER (BTU/Wh)	Min. HSPF (BTU/Wh)	Test Procedure
Split System			
Single-phase	10.0	5.9	CSA-C273.3-M91
Three-phase	10.0	5.9	"
Single Package			
Single-phase	9.7	5.7	CSA-C656-M92
Three-phase	9.7	5.7	"

Note: Effective 1995-96. SEER = seasonal energy efficiency ratio. HSPF = heating seasonal performance factor. Source: NRCan, 1995.

Table 2-23 Canadian Efficiency Standards for Heat Pumps

Product Class	Min. EER (BTU/Wh)	Min. COP (BTU/Wh)		Test Procedure
	Cooling	Cooling	Heating	
Ground Source				
Open System (10° C)	13.0	n/a	3.1	CSA-C446-94
Closed Loop (25° C)	11.5	n/a	n/a	"
Closed Loop (25° C)	n/a	n/a	2.8	"
Internal Water-Loop				
< 40 kW (135,000 BTU/h)	10.0	n/a	3.8	CSA-C655-M91

Note: Effective 1995-96. EER = energy efficiency ratio. COP = coefficient of performance.

2.3.1.4 Japan

Japan has target efficiency values for various products under the 1979 Energy Conservation Law. These targets were strengthened in 1993. Under the category of household appliances, Japan has target efficiency values for air-conditioners and televisions that are to be met by 1998. These target values are official regulations but no penalty is levied for not meeting them. However, most manufacturers meet the standard after negotiation with the government. Refrigerators and freezers do not have target efficiency values because their efficiency was thought to have improved sufficiently and also because the energy efficiency of these products will improve in the course of switching from CFC's to HCFC's in insulation and refrigerant.

The following tables list target efficiency values for Japanese household appliances.

Table 2-24 Japanese Target Efficiency Values for Combination Heating and Cooling Air-Conditioners

Product Class	Min. Cooling COP	Min. Heating COP	Minimum $\frac{\text{Cooling COP + Heating COP}}{2}$
Utilized cooling capacity ≤ 4 kW	2.19	2.38	2.33
Separate cooling capacity ≤ 4 kW	2.67	3.20	2.97
Cooling capacity 4 - 7.1 kW	2.34	2.56	2.50
Cooling capacity > 7.1 kWpresents	2.45	2.62	2.59

Note: Effective 1998. COP = coefficient of performance. Test procedure is JIS-B8616. Source: Turiel, Kollar and McMahon, 1995.

Table 2-25 Japanese Target Efficiency Values for Cooling Air-Conditioners

Product Class	Min. Cooling COP
Utilized cooling capacity ≤ 4 kW	2.45
Utilized cooling capacity 4 - 7.1 kW	2.20
Separate cooling capacity ≤ 4 kW	3.09
Separate cooling capacity 4 - 7.1 kW	2.42
Cooling capacity > 7.1 kW	2.45

Note: Effective 1998 COP = coefficient of performance. Test procedure JIS-C9612. Source: Turiel, Kollar and McMahon, 1995.

Table 2-26 Japanese Target Efficiency Values for Televisions

Product Class	Max. Energy Consumption (kWh/yr)
Standard ≤ 21 inches	6.24S + 14.5 + A
Standard ≥ 22 inches	6.24S + 34.2 + B
Wide-screen	7.06S + 53.9 + B
HDTV	9.86S + 99.4

Note: Effective 1998. Based on 4.5 hours of operation and 19.5 hours of stand-by time per day. Excludes LED televisions. S = screen size in inches. Test procedure is JIS-C6101.

A and B are:

	A	B
Built-in broadcast satellite reception	16.4	
Built-in video-deck	44.6	44.6
Built-in broadcast satellite reception and video-deck	61.0	
Other	0	0

2.3.1.5 Europe

Western European governments were among the first to introduce legislation to limit the energy consumption of domestic appliances. France introduced mandatory minimum efficiency standards for refrigerators in 1966 and for freezers in 1978. However, much of this early legislation was weak, poorly implemented and had little impact on appliance energy consumption. During the late 1970s and early 1980s, pressure to harmonize European trading conditions led to the repeal of almost all of this nationally-based legislation.

As of late 1995, with the exception of Switzerland, there are no mandatory minimum efficiency standards for residential appliances in western Europe. However, under pressure from the Netherlands, the European Union is in the process of developing efficiency standards. The Commission of the European Communities is targeting refrigerators and freezers for the first EU-wide efficiency standard on household appliances. Table 2-27 lists the refrigerator and freezer standards that have been proposed for introduction in the year 2000 throughout the European Union.

Table 2-27 Proposed European Union Efficiency Standards for Refrigerators and Freezers

Product Class	FF	Max. Energy Consumption (kWh/yr)
Refrigerator without FFC	1.00	237 + 0.225AV
Refrigerator with 1-star FFC	1.55	178 + 0.599AV
Refrigerator with 2-star FFC	1.85	238 + 0.437AV
Refrigerator with 3-star FFC	2.15	221 + 0.616AV
Refrigerator with 4-star FFC	2.15	303 + 0.778AV
Refrigerator-Cellar	0.75	237 + 0.225AV
Chest Freezer	2.15	195 + 0.480AV
Upright Freezer	2.15	289 + 0.478AV

Note: FFC = frozen food compartment, FF = freezer factor, AV = adjusted volume, in liters. For refrigerators and freezers with auto-defrost, AV = 1.2 x (refrigerator volume + (FF x freezer volume)). For refrigerators and freezers with manual defrost; AV = refrigerator volume + (FF x freezer volume). Source: Waide, 1995.

In 1990, Switzerland adopted a 'target values' approach to appliance efficiency. This approach combines the threat of mandatory standards and a sales-weighted method of defining appliance efficiency. The Swiss government stated that it would introduce mandatory minimum efficiency standards unless the average efficiency of the sales-weighted stock of new appliances met a minimum level by certain dates. This approach necessitates a complex evaluation process because the Swiss authorities must track all models sold on the market to determine whether the target has been met (Waide, Lebot and Hinnells, 1995). Table 2-28 lists the products for which target values have been issued.

Table 2-28 Household Appliances Covered by Target Efficiency Values in Switzerland

Domestic Refrigerators and Refrigerator-Freezers
Freezers
Electric Ovens
Dishwashers
Clothes Washers
Clothes Dryers
Televisions
Video Cassette Recorders (VCRs)

Tables 2-29 to 2-31 list the Swiss target values for household appliances.

Table 2-29 Swiss Target Efficiency Values for Refrigerators and Freezers

Product Class	FF	Max. Energy Consumption (kWh/yr)
Refrigerator without FFC	1.00	200 + 0.591AV
Refrigerator with 1-star FFC	1.55	200 + 0.591AV
Refrigerator with 2-star FFC	1.85	200 + 0.591AV
Refrigerator with 3-star FFC	2.15	200 + 0.591AV
Refrigerator with 4-star FFC	2.15	163 + 0.813AV
Chest Freezer	2.15	145 + 0.438AV
Upright Freezer	2.15	278 + 0.338AV

Note: Effective 1994 AV = adjusted volume, in liters FF = freezer factor AV = refrigerator volume + (FF * freezer volume)). Source: Waide, Lebot and Hinnells, 1995

Table 2-30 Swiss Target Efficiency Values for Household Appliances

Appliance	Sub-Categories	Max. Energy Consumption
Electric Ovens	With exhaust fans	0.9 kWh per cycle
	Other	0.8 kWh per cycle
Dishwashers	For less than 8 place settings	0.13 kWh per setting
	For 8 or more place settings	0.12 kWh per setting
Clothes Washers	--	0.23 kWh per kg of clothes
Clothes Dryers	Air exhaust	0.60 kWh per kg of clothes
	Water condensation	0.65 kWh per kg of clothes
	Air condensation	0.70 kWh per kg of clothes

Note: Effective 1997. Source: Waide, Lebot and Hinnells, 1995.

Table 2-31 Swiss Target Efficiency Values for Televisions and VCRs

Product	Operating Mode	Max Energy Consumption (W)	Effective (end of)
Televisions	Stand-by	3	1997
Video Cassette Recorders (VCRs)	Stand-by	3	1998

Source: Waide, Lebot and Hinnells, 1995.

2.3.1.6 Central and Eastern Europe

At present there are no efficiency standards in central European countries. Standards do exist in the Russian Federation and other Commonwealth of Independent States nations. Russia has efficiency standards for refrigerators, vacuum cleaners, irons and electric kettles. However, the refrigerator standards are not enforced and it is believed that the same applies to the other standards.

In September 1994, Russia signed a Memorandum of Co-operation with the U.S. Department of Energy to initiate a new program to promote appliance efficiency in Russia. The agreement has the ambitious goal of harmonizing Russian and U.S. appliance standards, testing and certification procedures. The intention appears to be to bring Russian appliances up to the levels of efficiency prescribed in the U.S. NAECA legislation. The appliances initially targeted are refrigerators and freezers, electric motors, residential boilers and lighting ballasts.

2.3.1.7 Asia (excluding Japan)

At least four Asian countries other than Japan have mandatory minimum efficiency standards for household appliances, including China, Korea, the Philippines and Taiwan. Thailand is in the process of developing efficiency standards. The major barriers to Thai standards at this point in time are the lack of a suitable testing facility and uncertainty over which international standard to adopt. The Thai government is targeting refrigerators, air-conditioners, ballasts, motors and windows for standards. India has voluntary efficiency standards for refrigerators that are weak compared to those in other countries.

2.3.1.7.1 China

The Chinese State Technology Supervision Bureau (STSB) has responsibility for efficiency standards on household appliances in China. To date, the agency has established standards for refrigerators, air-conditioners, clothes washers, fans, rice cookers and irons. Work is underway to revise the existing refrigerator and air-conditioner standards.

The refrigerator standard varies as a function of size and has eliminated particularly inefficient models from the market. Table 2-32 lists the standards for refrigerators and clothes washers while Table 2-33 lists those for air-conditioners.

Table 2-32 Chinese Efficiency Standards for Household Appliances

Product	Type/Size	Unit of Measure	Standard
Refrigerator	189-209 liters	Max Energy Consumption	475 kWh per year
Clothes Washers	Automatic	"	38 Wh per kg of clothes
	Two-tub with auto wash/rinse cycle control	"	32 Wh per kg of clothes

Note: Effective 1989. Refrigerator energy consumption is measured at an ambient temperature of 27°C. Two-tube clothes washers consist of one bin for washing and a second for spinning. Clothes must be manually transferred from one bin to the other. Source: Turiel, Kollar and McMahon, 1995.

Table 2-33 Chinese Efficiency Standards for Room Air-Conditioners

Cooling Capacity (Watts)	Minimum COP	
	Window-unit	Split-system
$W \leq 2500$	2.20	2.30
$2500 < W < 4500$	2.26	2.37
$W \geq 4500$	2.32	2.44

Note: Effective: 1989. COP = coefficient of performance. Source: Nadel, Pietsch and Yingyi, 1995.

2.3.1.7.2 Korea

In 1992, Korea introduced efficiency standards for refrigerators, air-conditioners, lighting equipment and passenger cars. Korea used a two-step approach in introducing its standards. The first standards became effective at the end of 1993 and were designed to reduce energy consumption by up to seven percent. A second set of standards became effective at the end of 1995 and were designed to reduce energy consumption by 10 to 30 percent.

Table 2-34 lists the Korean standards for refrigerators and refrigerator-freezers. These standards are designed to reduce energy consumption by 15 and 20 percent, respectively, from 1992 levels.

Table 2-34 Korean Efficiency Standards for Refrigerators and Refrigerator-Freezers

Product Type	Size	Max. Energy Consumption (kWh/month)
Refrigerator	Any	0.026AV + 12.39
Refrigerator-freezer	AV < 500 liters	0.043AV + 14.61
	AV > 500 liters	0.096AV - 11.71

Note: Effective 2000. AV = adjusted volume (in liters) = refrigerator volume + (2.3 x freezer volume). Source: Turiel, Kollar and McMahon, 1995.

Korea's efficiency standards for air-conditioners and heat pumps are designed to reduce energy consumption of single-package systems by 15 percent and split-systems by 20 percent, relative to 1991 levels. Table 2-35 lists these standards.

Table 2-35 Korean Efficiency Standards for Air-Conditioners and Heat Pumps

Product Type	Min. EER (kcal/h per Watt)
Single-package	2.8
Split-system (< Western 3,550 kcal/h)	3.1
Split-system (> 3,550 kcal/h)	2.8

Note: Effective 1995. EER = energy efficiency ratio. Source: Turiel, Kollar and McMahon, 1995.

2.3.1.7.3 Philippines

Philippine standards are issued by the Bureau of Product Standards (BPS) in the Department of Trade and Industry. To date, BPS has issued one efficiency standard, for room air-conditioners. Table 2-35 lists this standard. BPS is planning to issue efficiency standards for other products in the future, starting with refrigerators and irons.

Table 2-36 Philippine Efficiency Standards for Room Air-Conditioners

Size	Min. EER
< 12,000 kJ/h	7.9
12,000 to 26,000 kJ/h	7.4

Note: Effective 1993. EER = energy efficiency ratio. Source: Campanano, 1994 in Proceedings of ASEAN Workshop.

2.3.1.7.4 Taiwan

Taiwan's efficiency standards are issued by the Energy Committee, a government agency. Efficiency standards exist for a variety of products, including window air-conditioners (1981), fans (1982), water heaters, clothes dryers, ovens and stoves (1983), refrigerators (1986), and large air-conditioners (1987). Information on the exact standards was not available for this report.

2.3.1.8 Latin America

Mexico is the only country in Latin America with mandatory minimum efficiency standards, although Brazil has voluntary efficiency targets for refrigerators. To date, Mexico has issued standards for refrigerators, air-conditioners and motors. These standards and the associated test procedures are very similar to those used in the U.S.. In fact, the 1990 U.S. room air-conditioner standard becomes effective in Mexico in 1996. Mexico is in the process of developing other efficiency standards for incandescent lamps, well pumps, clothes washers and televisions.

Table 2-37 presents the Mexican standards for refrigerators and refrigerator-freezers. All product classes have standards that become effective in 1995 and three product classes have more stringent standards that become effective in 1997.

Table 2-37 Mexican Efficiency Standards for Refrigerator-Freezers

Product Class	Max. Energy Consumption (kWh/yr)	
	Effective 1995	Effective 1997
Refrigerators		
AV < 90 liters	0.476AV + 299	0.476AV + 299
AV > 90 liters	0.986AV + 254	0.476AV + 299
Refrigerator-Freezers		
Partial Auto-Defrost	0.491AV + 601	0.367AV + 398
Top-Mount Auto-Defrost	0.349AV + 545	0.564AV + 355
Side-by-side Auto-Defrost	0.416AV + 501	n/a
Bottom-Mount	0.582AV + 367	n/a
Top-Mount AD with Through-the-Door Features	0.620AV + 391	n/a
Side-by-side AD with Through-the Door Features	0.575AV + 527	n/a

Note: AV = adjusted volume In liters. AV = refrigerator volume + (1.63 x freezer volume). Source: Turiel, Kollar and McMahon, 1995.

2.3.2 Industrial and Commercial Equipment

The largest single end-use of electricity in virtually all countries is motors, making their efficiency a critical factor for environment and development. Mandatory minimum efficiency standards for motors and other industrial and commercial equipment can play an important role in increasing energy efficiency in these sectors.

This section begins with a summary of industrial and commercial equipment standards around the world which is followed by descriptions of individual standards in various countries.

2.3.2.1 Summary

At least six countries have mandatory minimum efficiency standards for industrial and commercial equipment. The United States and Canada have standards covering the greatest number of products. No European country has efficiency standards for this class of equipment while Japan has a standard for only one class of product (fluorescent lamps). Table 2-38 lists equipment covered by standards around the world.

Table 2-38 Industrial and Commercial Equipment Covered by Efficiency Standards Around the World

Product	U.S.	Canada	Japan	China	Korea	Malaysia
Fluorescent Lamp Ballasts	Y	Y			Y	
Fluorescent Lamps	Y	Y	Y		Y	
Incandescent Lamps	Y	Y			Y	
Electric Motors	Y	Y		Y		Y
Commercial AC/Heat Pumps	Y	Y				
Commercial Water Heaters	Y	Y				
Industrial/Commercial Furnaces/Boilers	Y	Y		Y		
Commercial Water Chillers		Y				

Products not included in Table 2-38 but for which standards are applicable include high-intensity discharge lamps, fractional-horsepower (less than one horsepower) and single-phase motors, distribution transformers, unit and duct heaters, packaged commercial refrigeration systems, fans, pumps and compressors.

2.3.2.2 United States

Mandatory minimum efficiency standards on industrial and commercial equipment in the United States are issued under 1988 amendments to the National Appliance Energy Conservation Act (NAECA) and the Energy Policy Act (EPACT) of 1992. The 1988 amendments to NAECA added fluorescent lamp ballasts to the list of regulated products while EPACT added various other products. The U.S. Department of Energy (DOE) implements the standards. Manufacturers are responsible for testing their own products but are subject to spot checks by the DOE.

Table 2-39 lists commercial and industrial equipment covered by efficiency standards under the 1988 NAECA amendment and EPACT and the effective dates of their initial standards. These standards cover an estimated 70 percent of commercial sector energy use.

Table 2-39 Industrial and Commercial Equipment Covered by Efficiency Standards in the U.S.

Act	Product	Effective Date of Initial Standard
NAECA Amendment	Fluorescent Lamp Ballasts	1990
EPACT	Fluorescent Lamps	1994-95
	Reflector Incandescent Lamps	1995
	Electric Motors (1-200 horsepower)	1997
	Commercial Air-Conditioners and Heat Pumps	1994-95
	Commercial Water Heaters	1994
	Commercial Furnaces and Boilers	1994

Note: Where a range of dates is shown, standards for different classes of products take effect on different dates. Source: ACEEE.

The initial standards for industrial and commercial equipment were written right into the EPACT legislation. This is in contrast to NAECA which instructed DOE to develop the initial standards. DOE will use the methodology outlined for household appliances to update the EPACT standards over time.

The U.S. motor standard experience provides an interesting story of policy development. There are more than one billion electric motors at work in the United States, consuming 60 percent of the nation's electricity. Of that, about 65 percent is used for motors in the industrial and commercial sectors. Only two percent of motors in the U.S. are larger than five horsepower, but they use 95 percent of the electricity consumed by motors.

The U.S. mandatory minimum efficiency standards for electric motors began as voluntary high efficiency standards developed by motor manufacturers. In 1987, the trade association for motor manufacturers, the National Electrical Manufacturers Association (NEMA), adopted voluntary consensus high efficiency standards for motors. The standards were used primarily to inform users which motors were energy-efficient. These standards were then adopted by the federal government when it legislated efficiency standards in 1992. The standards will take effect in 1997, a decade after being issued by the industry association.

The following tables list U.S. efficiency standards on industrial and commercial equipment. The corresponding test procedures are noted for each type of equipment. Again, some test procedures are contained in the U.S. Code of Federal Regulations (CFR) yet reference other test procedures.

Table 2-40 U.S. Efficiency Standards for Fluorescent Lamp Ballasts

Application	Ballast Input Voltage	Total Nominal Lamp Watts	Ballast Efficacy Factor
One F40T12 lamp	120 V	40	1.805
	277 V	40	1.805
Two F40T12 lamps	120 V	80	1.060
	277 V	80	1.050
Two F96T12 lamps	120 V	150	0.570
	277 V	150	0.570
Two 110W F96T12HO lamps	120 V	220	0.390
	277 V	220	0.390

Note: Effective 1990. Ballast power factors must be at least 0.9. Test procedure is in CFR 10 Part 430 and references ANSI C82.2-1984. Source: CFR.

Table 2-41 U.S. Efficiency Standards for Fluorescent Lamps

Lamp Type	Total Nominal Lamp Watts	Min. Average Lamp Efficacy (lumens/W)	Minimum Average CRI
4 foot medium bi-pin	≤ 35 W	75	45
	> 35 W	75	69
2 foot U-shaped	≤ 35 W	64	45
	> 35 W	68	69
8 foot slimline	≤ 65 W	80	45
	> 65 W	80	69
8 foot high output	≤ 100 W	80	45
	> 100 W	80	69

Note: Effective 1994-95. Test procedure is in CFR 10 Part 430 and references IES LM-9, -20, -45, -58 and -66 and CIE Publication No. 13.2. Source: CFR.

Table 2-42 U.S. Efficiency Standards for Incandescent Reflector Lamps

Nominal Lamp Wattage (W)	Minimum Average Lamp Efficacy (lumens/W)
40-50	10.5
51-66	11.0
67-85	12.5
86-115	14.0
116-155	14.5
156-205	15.0

Note: Effective 1995. Test procedure is in CFR 10 Part 430 and references IES LM-9, -20, -45, -58 and -66 and CIE Publication No. 13.2 Source: CFR.

Table 2-43 U.S. Efficiency Standards for Electric Motors

Nominal Full-Load Efficiency						
# of poles (rpm)	2 (3,600)		4 (1,800)		6 (1,200)	
hp	Open	Closed	Open	Closed	Open	Closed
1	---	75.5	82.5	82.5	80.0	80.0
1.5	82.5	82.5	84.0	84.0	84.0	85.5
2	84.0	84.0	84.0	84.0	85.5	86.5
3	84.0	85.5	86.5	87.5	86.5	87.5
5	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	89.5	88.5	89.5
10	88.5	89.5	89.5	89.5	90.2	89.5
15	89.5	90.2	91.0	89.5	90.2	90.2
20	90.2	90.2	91.0	91.0	91.0	90.2
25	91.0	91.0	91.7	91.0	91.7	91.7
30	91.0	91.0	92.4	92.4	92.4	91.7
40	91.7	91.7	93.0	92.4	93.0	93.0
50	92.4	92.4	93.0	93.0	93.0	93.0
60	93.0	93.0	93.6	93.0	93.6	93.6
75	93.0	93.0	94.1	93.6	93.6	93.6
100	93.0	93.6	94.1	94.1	94.1	94.1
125	93.6	94.5	94.5	94.1	94.1	94.1
150	93.6	94.5	95.0	95.0	94.5	95.0
200	94.5	95.0	95.0	95.0	94.5	95.0

Note: Effective 1997. These standards apply to general purpose, T-frame or IEC equivalent, single-speed, foot-mounting polyphase, squirrel-cage induction motors of NEMA design A or B or IEC design N, continuous rated, operating on 230, 460 or 575 volts and constant 60 Hertz line power. The test procedure is IEEE Standard 112 Test Method B which is virtually identical to the Canadian test procedure CSA-C390-93. Source: U.S. Energy Policy Act, 1992.

Table 2-44 U.S. Efficiency Standards for Commercial Air-Conditioners and Heat Pumps

Cooling Capacity	Type	Cooling	Heating	Test Procedure
Btu/h < 65,000	Air-cooled, split system	SEER > 10	HSPF > 6.8	ARI 210/240-89
	Air-cooled, single package	SEER > 9.7	HSPF > 6.6	"
	Water-cooled, evaporative	EER > 9.3		"
	Water source heat pump	EER > 9.3	COP > 3.8	"
65,000 ≤ Btu/h < 135,000	Air-cooled	EER > 8.9	COP > 3.0	ARI 210/240-89
	Water-cooled, evaporative	EER > 10.5		ARI 210/240-89 CTI 201 (86)
	Water source heat pump	EER > 10.5	COP > 3.8	ARI 320-86 CTI 201(86)
135,000 ≤ Btu/h < 240,000	Air-cooled	EER > 8.5	COP > 2.9	ARI 340/360
	Water-cooled, evaporative and water source heat pump	EER > 9.6		ARI 340/360

Note: Effective 1994-95. SEER = seasonal energy efficiency ratio, EER = energy efficiency ratio, HSPF = heating seasonal performance factor, COP = coefficient of performance. Source: EPACT.

Table 2-45 U.S. Efficiency Standards for Packaged Terminal Air-Conditioners and Heat Pumps

Min. EER (BTU/Wh)	Min. COP (BTU/Wh)
Cooling	Heating
10.0 - (0.16 x Cap)/1000	1.3 + (0.16 x Min. EER)

Note: Effective 1994. EER = energy efficiency ratio. COP = coefficient of performance Cap = capacity in Btu/h. Test procedure is ARI 310-90. Source: ASHRAE 90.1-1989.

Table 2-46 U.S. Efficiency Standards for Commercial Water Heaters

Type	Size	Max. Standby Loss (percent/hr)	Min. Thermal Efficiency (percent)
Electric			
Storage	0 < SV ≤ 140	0.30 + (27/SV)	
Instantaneous	SV < 10	n/a	80
	10 ≤ SV ≤ 140	2.30 + (67/SV)	77
Gas or oil			
Storage	IR ≤ 155,000, SV ≤ 140	1.30 + (114/SV)	78
	IR > 155,000, SV ≤ 140	1.30 + (95/SV)	78

Note: Effective 1994. SV = storage volume in gallons, IR = input rating in Btu/h. Test procedure is ANSI Z21.10.3-1990. Source: ASHRAE 90.1-1989.

Water heaters with a storage volume greater than 140 gallons are exempt from the above standards so long as their effective insulation R value is greater than 12.5 and they do not have a pilot light. Unfired hot water storage tanks up to 140 gallons must have a maximum heat loss of 6.5 Btu per hour per square foot of tank surface area.

Table 2-47 U.S. Efficiency Standards for Commercial Furnaces and Boilers

Product Class	Fuel	Capacity (Btu/h)	Min. Thermal Efficiency	Min. Combustion Efficiency	Test Procedure
Furnaces	Gas	≥ 225,000	80%		ANSI Z21.47-90
	Oil	≥ 225,000	81%		U.L. 727-86
Boilers	Gas	≥ 300,000		80%	ANSI Z21.13-87 H.I. Htg. Boiler Std. 86 ASME 795-73
	Oil	≥ 300,000		83%	U.L. 726-90 H.I. Htg. Boiler Std. 86 ASME PTC 4.1-64

Note: Effective 1994. Source: ASHRAE 90.1-1989.

2.3.2.3 Canada

Under the Federal Energy Efficiency Act of 1993, Canadian mandatory minimum efficiency standards on industrial and commercial equipment became effective in February, 1995. The standards apply to products that are imported into Canada or that cross provincial boundaries but do not apply to products manufactured and sold in the same province. The exclusion of the latter products is due to the division of power between federal and provincial governments in Canada. Also, the federal legislation does not preempt provincial legislation. Some provinces have more stringent standards than the federal government and products sold in these provinces have to meet the more stringent provincial standard. Manufacturers must receive third-party verification of their products' energy performance from certified testing facilities.

Table 2-48 lists industrial and commercial products that are covered by standards in Canada and indicates those that have common standards with the U.S..

Table 2-48 Industrial and Commercial Equipment Covered by Efficiency Standards in Canada

Product	Standard
Fluorescent Lamp Ballasts	See below
Fluorescent Lamps	Same as U.S.
Incandescent Reflector Lamps	Same as U.S.
Electric Motors	See below
Boilers	See below
Packaged Terminal Air-Conditioners and Heat Pumps	See below
Water Chillers	See below
Commercial Air-Conditioners and Heat Pumps	See Technical Annex

The following tables list the Canadian efficiency standards on industrial and commercial equipment that are different from those in the U.S. along with the relevant test procedures. Canada adopted the U.S. standards for fluorescent and incandescent reflector lamps. Canada adopted the U.S. motor standards and extended them to 8 pole motors.

Table 2-49 Canadian Efficiency Standards for Fluorescent Lamp Ballasts

Application	Ballast Input Voltage	Total Nominal Lamp Watts	Ballast Efficacy Factor
One F40T12 lamp	120 V	40	1.805
	277 V	40	1.805
	347 V	40	1.750
Two F40T12 lamps	120 V	80	1.060
	277 V	80	1.050
	347 V	80	1.020
Two F96T12 lamps	120 V	150	0.570
	277 V	150	0.570
	347 V	150	0.560
Two 1,10W F96T12HO lamps	120 V	226	0.390
	277 V	226	0.390
	347 V	226	0.380
Two F32T8 lamps	120 V	64	1.250
	277 V	64	1.230
	347 V	64	1.230

Note: Effective 1995. Ballast power factors must be at least 0.9. Source: NRCan, 1995.

Table 2-50 Canadian Efficiency Standards for Electric Motors

Minimum Nominal Efficiency								
# of poles (rpm)	2 (3,600)		4 (1,800)		6 (1,200)		8 (900)	
hp	Open	Closed	Open	Closed	Open	Closed	Open	Closed
1	75.5	75.5	82.5	82.5	80.0	80.0	74.0	74.0
1.5	82.5	82.5	84.0	84.0	84.0	85.5	75.5	77.0
2	84.0	84.0	84.0	84.0	85.5	86.5	85.5	82.5
3	84.0	85.5	86.5	87.5	86.5	87.5	86.5	84.0
5	85.5	87.5	87.5	87.5	87.5	87.5	87.5	85.5
7.5	87.5	88.5	88.5	89.5	88.5	89.5	88.5	85.5
10	88.5	89.5	89.5	89.5	90.2	89.5	89.5	88.5
15	89.5	90.2	91.0	89.5	90.2	90.2	89.5	88.5
20	90.2	90.2	91.0	91.0	91.0	90.2	90.2	89.5
25	91.0	91.0	91.7	91.0	91.7	91.7	90.2	89.5
30	91.0	91.0	92.4	92.4	92.4	91.7	91.0	91.0
40	91.7	91.7	93.0	92.4	93.0	93.0	91.0	91.0
50	92.4	92.4	93.0	93.0	93.0	93.0	91.7	91.7
60	93.0	93.0	93.6	93.0	93.6	93.6	92.4	91.7
75	93.0	93.0	94.1	93.6	93.6	93.6	93.6	93.0
100	93.0	93.6	94.1	94.1	94.1	94.1	93.6	93.0
125	93.6	94.5	94.5	94.1	94.1	94.1	93.6	93.6
150	93.6	94.5	95.0	95.0	94.5	95.0	93.6	93.6
200	94.5	95.0	95.0	95.0	94.5	95.0	93.6	94.1

Note: Effective 1996. These standards apply to general purpose, T-frame or IEC equivalent, single-speed, foot-mounting polyphase, squirrel-cage induction motors of NEMA design A or B or IEC design N, continuous rated, operating on 230, 460 or 575 volts and constant 60 Hertz line power. The test procedure is CSA-C390-93, included in the Technical Annex to this report. Source. NRCan, 1995.

Table 2-51 Canadian Efficiency Standards for Boilers

Product Class	Boiler Type	Min. AFUE	Min. SEUE	Test Procedure
Natural Gas				
< 88 kW (< 300,000 BTU/h)	Hot Water Steam	80%		CGA P.2-1991
	Low Pressure Steam System	75%		
Oil				
< 88 kW (< 300,000 BTU/h)			80%	CSA-B212-M93

Note: Effective 1996. AFUE = annual fuel utilization efficiency, SEUE = seasonal energy utilization efficiency
Source: NRCan, 1995.

Table 2-52 Canadian Efficiency Standards for Packaged Terminal Air-Conditioners and Heat Pumps

Min. EER (Cooling) (BTU/Wh)	Min. COP (Heating) (BTU/Wh)	Test Procedure
9.115 - 0.0000638 x Cap	2.75 - 0.00001 x Cap	CSA-C744-93 (ARI-310/380-93)

Note: EER = energy efficiency ratio. COP = coefficient of performance. Cap = capacity in Btu/h. Source: NRCan, 1995.

Table 2-53 Canadian Efficiency Standards for Water Chillers

Type		Capacity Range (kW)	Min. COP	Min. IPLV
Vapor Compression	Water-Cooled	0-500	3.80	3.90
		500-1,000	4.20	4.50
		>1,000	5.20	5.30
	Air-Cooled	0-500	2.70	2.80
		500-1,000	2.50	2.50
		>1,000	2.50	2.50
	Evap-Cooled	0-500	3.60	3.70
Absorption	Single-Effect, Indirect-Fired	All	+	+
	Double-Effect, Indirect-Fired	All	0.95	1.00
	Double-Effect, Direct-Fired	All	0.95	1.00

Note: Effective 1996 COP = coefficiency of performance. IPLV = Integrated Part Load Value. + = with waste heat or solar heat only; otherwise not allowed. Test procedure is CSA-C743-93. These standards are for factory-designed and prefabricated absorption or vapor-compression refrigeration chillers that are equipped with centrifugal, rotary screws or positive displacement (reciprocating or scroll) compressors with a cooling capacity not exceeding 5,600 kW (20,000,000 BTU/h) and intended for application in air-conditioning systems for buildings. Source: NRCan, 1995.

2.3.2.4 Japan

Japan has target efficiency values for various products under the 1979 Energy Conservation Law. They were strengthened in 1993. Under the category of industrial and commercial equipment, Japan has target efficiency values for fluorescent lamps that are to be met by the year 2000. These targets are official regulations but no penalty is levied for not meeting them. However, most manufacturers meet the target efficiency values after negotiation with the government. Japan does not have target efficiency values for motors. Table 2-54 lists the target efficiency values for fluorescent lamps.

Table 2-54 Japanese Target Efficiency Values for Fluorescent Lamps

Purpose of Lamp	Target Value (lumens/watt)
For Commercial and Public Lighting	75
For Residential Lighting	62

Note: Effective 2000. Test procedure is JIS-C8105. Source: Fujino.

2.3.2.5 Western Europe

Western European nations do not have efficiency standards for industrial or commercial equipment. The European Union is investigating the prospect of issuing efficiency standards for industrial electric motors and commercial lighting equipment.

2.3.2.6 Asia (excluding Japan)

2.3.2.6.1 Summary

At least three Asian countries outside Japan have mandatory minimum efficiency standards for industrial and commercial equipment, including China, Malaysia and Korea.

2.3.2.6.2 China

Under the category of industrial and commercial equipment, China has efficiency standards for motors, lighting equipment, industrial boilers, furnaces and kilns. They are implemented by the State Technology Supervision Bureau and the energy conservation departments of the State Planning Commission, the State Economy and Trade Commission and other concerned ministries. Information on the exact standards was not available for this report.

2.3.2.6.3 Malaysia

In 1989, the Ministry of Energy, Telecommunications and Posts issued efficiency standards for motors in Malaysia. Table 2-55 lists these standards.

Table 2-55 Malaysian Efficiency Standards for Motors

Size (kW)	Min. Rated Efficiency (percent)
0.4	72
0.8	78
4	83
8	85
40	90
80	91.5
100	92

Source: Kannan in Proceedings of ASEAN Workshop, 1994.

2.3.2.6.4 Korea

Korea introduced efficiency standards in 1992. Under the category of industrial and commercial equipment, it has issued standards for fluorescent lamps and ballasts and incandescent lamps. Korea used a two-step approach in introducing its standards. The first standards became effective at the beginning of 1994 and were designed to reduce energy consumption by up to seven percent. A second set of standards became effective at the beginning of 1996 and were designed to reduce energy consumption by 10 to 30 percent. Tables 2-56 to 2-58 list these standards.

Table 2-56 Korean Efficiency Standards for Fluorescent Lamps

Type	Watts	Min. Lumens per Watt	
		(1994)	(1996)
Straight	20	60.0	72.0
Straight	40	70.0	85.0
Circular	30	53.0	68.0

Note: Test procedure is KS C 7601-1986. Source. Korea Institute for Energy Research.

Table 2-57 Korean Efficiency Standards for Fluorescent Lamp Ballasts

Type	Watts	Min. Efficiency	
		(1995)	(1997)
Straight	20	0.92	1.15
Straight	40	0.97	1.18
Circular	30	0.97	1.15

Note: Min. efficiency is defined as the measured ballast efficiency compared to a reference ballast efficiency. Test procedures are KS C 8102-1981 and KS C 8100-1992. Source: Korea Institute for Energy Research.

Table 2-58 Korean Efficiency Standards for Incandescent Lamps

Voltage	Watts	Min Lumens per Watt	
		(1994)	(1996)
110	30	10.0	12.8
110	60	12.0	15.0
110	100	14.0	16.5
220	30	8.0	10.0
220	60	10.0	13.0
220	100	12.0	14.6

Note: Test procedure is KS C 7501-1986. Source: Korea Institute for Energy Research

2.3.3 Office Equipment[4]

Office equipment is a relatively small end-use of energy in developing countries but is growing quickly along with the commercial sector as a whole.

This section begins with a summary of office equipment efficiency standards around the world which is followed by descriptions of individual standards in various countries.

[4] This section is based largely on McMahon, Piette and Kollar, 1995.

2.3.3.1 Summary

Only two countries have efficiency standards for office equipment, Japan and Switzerland. Even then, these standards are voluntary target efficiency values. The Japanese target values are widely met and the Swiss target values are backed up by a threat to impose mandatory efficiency standards if they are not met. Denmark has proposed mandatory efficiency standards for office equipment but these may be changed to voluntary standards due to pressure from the European Union.

Neither North American nor other Western European nations have mandatory minimum efficiency standards (MMES) for office equipment. The European Union is investigating the prospect of issuing MMES for office equipment.

2.3.3.2 Japan

Japan has target efficiency values for various products under the 1979 Energy Conservation Law. These target values were strengthened in 1993. Under the category of office equipment, Japan has target efficiency values for copiers, computers and magnetic disk units that are to be met by the year 2000. These targets are official regulations but no penalty is levied for not meeting them. However, most manufacturers meet the target efficiency values after negotiation with the government. Figure 2-1 displays the Japanese target efficiency values for copiers while Tables 2-59 to 2-61 list the target efficiency values for copiers, computers and magnetic disk units.

Figure 2-1 Japanese Target Efficiency Values for Copiers

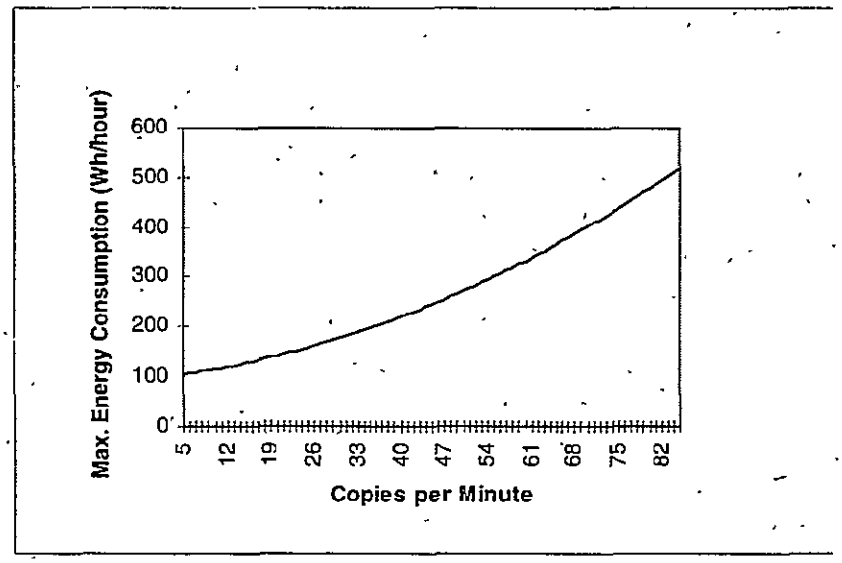


Table 2-59 Japanese Target Efficiency Values for Copiers

X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
5	106	16	130	27	165	38	210	49	266	60	332	71	409	82	496
6	107	17	133	28	169	39	215	50	272	61	339	72	416	83	504
7	109	18	136	29	173	40	220	51	277	62	345	73	424	84	512
8	111	19	139	30	176	41	225	52	283	63	352	74	431	85	521
9	113	20	142	31	180	42	230	53	289	64	359	75	439		
10	116	21	145	32	184	43	235	54	295	65	366	76	447		
11	118	22	148	33	189	44	240	55	301	66	373	77	455		
12	120	23	151	34	193	45	245	56	307	67	380	78	463		
13	122	24	155	35	197	46	250	57	313	68	387	79	471		
14	125	25	158	36	201	47	255	58	319	69	394	80	479		
15	128	26	162	37	206	48	261	59	326	70	401	81	487		

Note: Effective 2000. X = copier performance in copies per minute. Y = max. energy consumption in Wh/hour

Table 2-60 Japanese Target Efficiency Values for Computers

Computer Speed (CS)	Max. Energy Consumption (kW)
CS < 1	0.2
1 ≤ CS < 3	0.06
3 ≤ CS < 10	2.0
10 ≤ CS < 30	6.0
30 ≤ CS < 100	20.0
100 ≤ CS < 300	60.0
300 ≤ CS < 1,000	200.0
1,000 ≤ CS < 3,000	600.0

Note: Effective 2000. CS in million theoretical operations per second (MTOPS) These target values apply to the main computer unit, excluding display or printers. They do not apply to computers with operational performance greater than 3,000 MTOPS and computers employed for dedicated purposes (e.g. computers which specifically designed to be built into other machines or devices). Source: MITI.

Table 2-61 Japanese Target Efficiency Values for Magnetic Disk Units

Type	Power Consumption (W) / Memory Capacity (Mbytes)
Single Magnetic Disk Drive	≤ 0.01
Disk Subsystem	≤ 0.03

Source: MITI

2.3.3.3 Switzerland

In 1990, Switzerland adopted a 'target values' approach to office equipment efficiency. This approach combines the threat of mandatory standards and a sales-weighted method of defining office equipment efficiency. The Swiss government stated that it would introduce mandatory minimum efficiency standards unless the average efficiency of the sales-weighted

stock of new office equipment met a minimum level by certain dates. This approach necessitates a complex evaluation process because the Swiss authorities must track all models sold on the market to determine whether the target has been met (Waide, Lebot and Hinnells, 1995). Table 2-62 lists the Swiss target values for office equipment.

Table 2-62 Swiss Target Efficiency Values for Office Equipment

Product Class	Operating Mode	Max. Energy Consumption (W)	Effective (end of)
Work Station Computers[1]	On	5	1997
	On	3	1999
Personal Computers			
(with integrated monitor)	Stand-by	15	1997
(with integrated monitor)	Stand-by	13	1999
(without integrated monitor)	Stand-by	10	1997
Monitors[2]	Stand-by	5	1997
	Stand-by	3	1999
Printers[3]	Stand-by	2	1996
	Off	1	1996
Copiers[4]	Stand-by	27 + 3.23CPM	1996
	Off	1	1996
Fax Machines[5]	Stand-by	2	1997

Note: CPM means copies per minute. Source: Waide, Lebot and Hinnells, 1995.

[1] Applies to desktop and tower models for use at work desks, including those with a monitor integrated in the same casing. Does not apply to laptops and computers built to act as servers.

[2] Applies to monitors up to 21" across diagonally.

[3] Applies to printers with a printing speed of up to 25 pages per minute.

[4] Does not apply to copiers with a speed over 100 copies per minute, copiers made for paper size greater than A3 or full-color copiers. Test procedure is American Society for Testing and Materials (ASTM) test procedure titled *Determining Energy Consumption of Copier and Copier-Duplicating Equipment.*

[5] Applies to fax machines with additional function such as an integrated telephone, answering machine, etc.

2.3.3.4 Denmark

The Danish Energy Agency has the authority to set efficiency standards for equipment, including office equipment. The following standards have been proposed to become effective in 1997, although they may be changed to voluntary standards due to pressure from the European Union.

Table 2-63 Proposed Danish Efficiency Standards for Office Equipment

Product	Operating Mode	Max. Energy Consumption (W)
Personal Computers	Standby	10
Monitors	Standby	30
Printers	Standby	46
Fax Machines	Standby	2
Copiers		
CPM ≤ 20	Standby	6 to n/a
CPM > 44	Standby	6 to 233

Note: Effective 1997. CPM means copies per minute. The range in the max. energy consumption for copiers is related to copier speed. Source: McMahon, Piette and Kollar, 1995.

2.4 Motor Vehicle Fuel Economy Standards[5]

At least five OECD countries and Korea have fuel economy standards for motor vehicles. The U.S. has mandatory standards for passenger cars and light truck vehicles (small pickup trucks, sport-utility vehicles and minivans). Canada and Korea have mandatory standards for cars. Japan has fuel economy targets for cars. Like target efficiency values for appliances and office equipment, these targets are voluntary but widely met due to the strong cooperation between government and manufacturers. Sweden and Australia have voluntary fuel economy standards for cars. All of the standards are based on the weighted average fuel efficiency of new vehicles of a certain size or of a certain brand. In the U.S. they are called Corporate Average Fuel Economy (CAFE) standards.

Table 2-64 lists fuel economy standards in the U.S., Canada, Korea, Australia and Sweden and Table 2-65 lists those in Japan.

Table 2-64 Motor Vehicle Fuel Economy Standards in the U.S., Canada, Australia and Sweden

Country	Legal Status	Max. Energy Consumption (liters/100 km)	Effective
United States	Mandatory	Autos: 8.8 LTVs: 6.5	1996 1996
Canada	Mandatory	Autos: 8.6	1991
Korea	Mandatory	n/a	1993
Australia	Voluntary	Autos: 8.7	1988
Sweden	Voluntary	Autos: 7.1 - 8.5	1986

Note. LTVs = light truck vehicles. Source: IEA, 1991.

The U.S. and Australian standards are based on the 1975 U.S. FTP test procedure, administered in the U.S. by the Environmental Protection Agency. Fuel economy is defined as the weighted average fuel economy under urban (55%) and highway (45%) driving conditions.

[5] This section is based on IEA, 1991.

The test procedures for urban and highway driving are listed in the U.S. Code of Federal Regulations, Vol. 40, Part 86 (Appendix) and Part 600, respectively.

Table 2-65 Japanese Automobile Fuel Economy Standards

	Weight (kg)	Max. Energy Consumption (liters/100 km)
For Manufacturers Selling More than One Size of Cars	< 827.5	5.3
	827.5 ≥ W > 1,515.5	7.7
	≥ 1,515.5	11.0
For Manufacturers Selling Only One Size of Car	< 702.5	5.2
	702.5 ≥ W < 827.5	5.5
	827.5 ≤ W < 1,015.5	6.1
	1,015.5 ≤ W < 1,515.5	8.3

Note: Effective 2000. Source: MITI

2.5 Test Procedures[6]

Labeling programs, building codes and efficiency standards depend on test procedures and testing facilities to measure energy efficiency or energy consumption. Test procedures are issued by standards organizations around the world. Major standards organizations include the following:

International	International Organization for Standardization (ISO) International Electro-technical Committee (IEC)
U.S.	Association of Home Appliance Manufacturers (AHAM) American National Standards Institute (ANSI) Air-Conditioning and Refrigeration Institute (ARI) American Society of Heating, Refrigeration & Air-Conditioning Engineers (ASHRAE) American Society of Mechanical Engineers (ASME) Illuminating Engineering Society of North America (IES)
Canada	Canadian Standards Association (CSA)
Europe	European Committee for Standardization (CEN) European Electro-technical Committee for Standardization (CENELEC)
Japan	Japan Institute of Standards (JIS)
China	National Bureau of Standards

ISO and IEC have issued international standards for selected products, including refrigerators (ISO 7371:1985), refrigerator-freezers (ISO 8187:1991), freezers (ISO 5155:1983), room air-conditioners (ISO 5151:1994), water heaters (IEC 379), clothes washers (IEC 456),

[6] This section is based largely on Turiel, Kollar and McMahon, 1995.

fluorescent lamps (IEC 901, 921, 969) and incandescent lamps (IEC 64). Test procedures issued by the national standards organizations are listed in the sections above.

There are instances of both harmonization and diversity in test procedures around the world. In Europe, for instance, CEN and CENELEC have issued a common test procedure for refrigerators (EN 153) which is largely based on an ISO test procedure (ISO 8187). However, all other products have different test procedures in each country, although they are generally based on ISO test procedures.

The following table gives an example of the differences between test procedures around the world. It shows the principal parameters used in ISO, Japanese, U.S., Australian and Chinese test procedures for the measurement of refrigerator-freezer energy consumption.

Table 2-66 Refrigerator-Freezer Energy Consumption Test Procedure Parameters

Parameter	ISO	JIS	U.S.	Australia/NZ	China
Ambient Temperature	25°C	15 & 30°C	32.2°C	32°C	30°C
Fresh Food Compartment	5°C	3°C	3.3°C	3°C	3°C
Freezer Temperature	-18°C	-18°C	-15°C	-15°C	-18°C
Door Openings	No	Yes	No	No	No
Loading	Yes	No	No	No	No

Source. Turiel, Kollar and McMahon, 1995.

The U.S., Australian and Chinese test procedures are similar to each other, with only small differences in the ambient and cabinet temperatures. Canada and Mexico have test procedures that are very similar if not harmonized with the U.S. test procedure. The ISO test procedure, used throughout the European Union, differs from these test procedures in that it uses a lower ambient temperature and requires that the appliance be loaded with food or substitute materials. The Japanese test procedure is very different from the rest, requiring two ambient temperatures and door openings.

3. Assessment of Existing Labeling Programs, Building Codes and Efficiency Standards

A review of the literature found no comprehensive assessments of energy labeling programs, efficiency standards or building codes. In the absence of these assessments, this section provides a simple review of experiences with these policy measures, grouping them into successes and failures. Success is defined as meeting or exceeding the apparent goals of the measure. Failure is defined as obviously failing to meet the goal. A few lessons from this review are then offered at the end of the section.

3.1 Successes

Refrigerator testing in Brazil has generated energy savings even though the associated labeling program was a failure. Testing and labeling of all domestic refrigerators began in 1985. Even though many refrigerators were sold without labels, the testing program exposed manufacturers who made inefficient products, and as a result, several manufacturers improved the efficiency of some of their models. This example reveals how the simple act of measuring appliance energy efficiency can have an impact on the market (see section 2.3.1.8).

The U.S. Energy Star program achieved early success by garnering widespread participation by manufacturers, especially among personal computer and printer manufacturers. Two years after implementation, over 50 percent of personal computers and 80 percent of printers were compliant with Energy Star high efficiency standards. Average power requirements of personal computers in active mode have fallen from 75 or 80 watts a few years ago to 35 or 45 watts today, largely due to the Energy Star program. This success can be attributed to effective marketing by the Energy Star program and the strong competitiveness of the computer industry which drives computer manufacturers to make their products as attractive as possible to consumers (see section 2.1.2).

U.S. mandatory minimum efficiency standards are another success story. These standards have been effectively implemented and enforced. They are also periodically updated which takes advantage of advances in technology. Regular updates are important because they keep manufacturers constantly working on ways to improve energy efficiency. Standards have resulted in large energy savings and large consumer benefits, as noted in section 4.6. It is estimated that for every $1 increase in the price of products due to U.S. efficiency standards, consumers save an average of $3.20 on energy consumption over the life of the product (see section 2.3.1.2).

3.2 Failures

Introducing harmonized energy labels in Europe has taken an inordinate amount of time. Seventeen years elapsed between initiation and implementation of common labels for European refrigerator-freezers, largely due to the lack of central leadership and universal agreement among European Union countries. Common labels for other household appliances are still pending (see section 2.1.4).

The initial United States Energy Guide labels were largely ineffective because they were difficult to understand yet went unchanged for over a decade. They were finally updated in 1994 (see section 2.1.2).

Most building codes suffer from low rates of compliance and therefore do not achieve their potential energy savings. Low compliance results largely from insufficient resources for enforcement and excessively complex codes. Numerous studies in the U.S. report rates of non-compliance of 50 percent or more. An exception to this is Singapore where compliance with building codes is reported to be very high (see section 2.2).

Early efficiency standards in France, introduced in 1966 for refrigerators and in 1978 for freezers, had little impact on appliance energy consumption because the legislation was weak and poorly implemented. Similarly, existing efficiency standards in Russia are not being enforced (see section 2.3.1.5).

Automobile and light truck fuel economy standards in the United States were successful at first but have remained at an inefficient level for years due to opposition from vehicle manufacturers. This is mainly due to the fact that efficiency improvements tend to reduce the driving performance and marketability of vehicles. Standards on most other products do not affect product performance to the same extent and therefore face less opposition (see section 2.4).

3.3 Lessons

A few obvious lessons can be derived from the above experiences.

First, effective implementation is a prerequisite for successful efficiency measures. Energy efficiency policies are labor and management intensive because they, by necessity, affect so many consumers and companies and because they are based on technology that is always changing. Effective energy labeling rules, building codes and efficiency standards require careful consideration of technical, marketing, bureaucratic and political factors. The failure of virtually all of the above examples can be traced to one or more of these four factors.

Second, periodic updates of standards are necessary to realize the full benefits of efficiency standards. Technology can evolve quickly and standards need to be changed in order to take advantage of this evolution. Obsolete standards fail to provide new energy savings and related benefits.

Third, regionally harmonized standards add an extra layer of political and bureaucratic obstacles to the implementation process, yet offer economies of scale at the same time. Convincing a number of neighboring countries to adopt the same or similar standards can help to reduce the opposition to standards among appliance and equipment manufacturers. Yet they require coordination between governments with different objectives. Harmonized standards should therefore be considered for implementation but not pursued without careful advance consideration of the extra burden of international cooperation.

Fourth, building codes are more difficult to implement than standards. They typically involve many more variables, since buildings vary in size and location, and require more resources for enforcement. Efficiency standards can be enforced by periodic testing of selected

mass-produced items whereas the enforcement of building standards requires multiple visits to individual buildings during construction.

4. Impacts from the Introduction or Expansion of Efficiency Standards and Building Codes in Selected Developing Countries

This section discusses the impacts of efficiency standards and building codes in developing countries. It begins with an overview of the range of impacts that occur when efficiency standards or building codes are introduced. Then, it presents preliminary estimates of potential energy savings, carbon emission reductions and export market impacts from the introduction or expansion of building codes and mandatory minimum efficiency standards in five developing countries. The countries are India, Indonesia and the Philippines in Asia and Brazil and Mexico in Latin America. Finally, it presents existing estimates of the economic impacts of efficiency standards in the United States and Mexico.

4.1 Range of Impacts from Efficiency Standards and Building Codes

Efficiency standards and building codes result in a range of impacts on various stakeholders. These stakeholders include the building construction industry, appliance manufacturers, building owners and tenants, appliance and equipment owners, energy suppliers and the environment. The major types of impacts from efficiency standards and building codes include the following:

- Appliance and equipment manufacturers may incur additional costs, modify their production process or change the set of products offered to the market. Once manufacturers meet the standards, sales of products may change. The construction industry faces additional costs and the need to modify construction practices.

- Appliance and equipment consumers are also affected by changes in price and product performance, especially operating costs. Building owners face changes in the price of buildings and reduced operating costs. Tenants typically enjoy greater comfort and may share in reduced operating costs.

- Energy suppliers lose revenues and avoid costs. The net effect depends on this mix of revenues and costs. The need for new electricity generation facilities is diminished.

- The environment derives benefits from reduced air pollution and greenhouse gas emissions and other environmental impacts associated with energy production and transportation.

4.2 Methodology

This analysis assumes that efficiency standards and building energy codes become effective in the year 2000. Building codes are assumed to cover both commercial and residential buildings. Efficiency standards are best applied to mass-produced products that are used in roughly the same way by all consumers. For this analysis, it is assumed that standards are issued for mass-produced products that consume significant amounts of commercial energy in the selected countries and whose efficiency can be improved through standards. These products are mostly powered by electricity but include oil- and coal-fired boilers, diesel pumps and motor vehicles. In those areas where standards or building codes already exist, the analysis assumes

that these standards or codes are strengthened, generating incremental energy savings. The following products are assumed to be covered by standards in this analysis.

Table 4-1 Products Covered by Efficieney Standards

Sector	Product
Industrial	Boilers Electric Motors Lighting
Commercial	HVAC Lighting Refrigeration Equipment
Residential	Refrigerators Air-conditioners Fans Water Heaters Clothes Washers Lighting Televisions
Agriculture	Electric and Diesel Pumps
Transportation	Cars and Light Trucks

The analysis included the following steps:

1. Data were collected on commercial energy consumption, growth rates, end-use shares, potential efficiency improvements and average product lifetimes in the various countries.

2. The market penetration of efficient products and buildings, both new and replacement, was calculated based on energy consumption growth and average product lifetimes, respectively.

3. Energy consumption for each product category was projected into the future with and without standards, based on the assumed growth rates. Potential energy savings for each product due to standards were taken from estimates of efficiency potential in the literature. The potential savings figures used in this analysis represent aggressive estimates. Energy savings were calculated based on the difference between energy consumption with and without standards.

4. Data were collected on the fuel mix of electricity generation and on transmission and distribution losses in the various countries. Carbon emission reductions from standards on electric products were calculated based on these figures and assume that the country's marginal electricity fuel source is equal to the existing fuel mix. To these were added the reductions in carbon emissions from products that use fossil fuels directly.

5. Data were collected on the average annual unit energy consumption of each product. The total energy consumed in a given year by all new efficient products (e.g. the sum of new and replacement products purchased in that year) was divided by average annual unit energy consumption to estimate annual sales of products. Annual sales of efficient products were then used as an indicator of the export market impact of standards.

There are numerous alternative ways to conduct this type of analysis, each involving different amounts of data and research effort. This approach was adopted based on the available data, time and resources. It has the following major deficiencies:

1. It adopts a top-down approach to simulate change in energy efficiency when a bottom-up approach is more accurate. This top-down approach "grows" aggregate energy consumption over time and subtracts savings due to standards. A bottom-up approach would have "grown" the stock of energy-using products and used estimates of unit energy consumption to calculate aggregate energy consumption and savings. The latter approach is more accurate but requires data on the stock and energy consumption characteristics of each product in each country. These data were not available for this analysis.

2. It assumes that the structure of energy consumption within each sector and between sectors remains constant when it will actually change over time. For instance, the share of refrigerator consumption in India's residential sector is growing as is the residential share of total electricity consumption. A constant structure of energy consumption was adopted due to the absence of reliable forecasts of the future structure of energy consumption. However, the analysis used projected rather than current end-use shares of energy consumption to reduce the error in this approach.

3. It measures savings from a frozen efficiency baseline and assumes no natural increase in energy efficiency. In reality, energy efficiency would increase in the absence of standards through the penetration of new technology. Taking this natural change into account was impossible here due to the unavailability of data on current and forecast efficiency of products under a natural change scenario.

4. It assumes that energy savings from standards and product lifetimes are roughly the same in each country when these factors will in fact differ due to differences in technology and operating conditions. This simplification was adopted in the absence of efficiency potential and product lifetime figures for each country.

5. It assumes that energy supply and demand are in balance. In some developing countries, particularly India, demand exceeds supply. Electric utilities in these countries must impose power cuts and rotating shutdowns of customers in order to distribute their limited supply during peak periods. In situations such as these, efficiency standards reduce energy consumption in off-peak periods and free up generating capacity to serve otherwise unserved peak demand. To the extent that the analyzed countries continue to suffer from excess demand in the future, this analysis overestimates energy savings and carbon emission reductions associated with standards.

Detailed assumptions are too numerous to show here and are, in any event, meant to change in light of more accurate information.

Despite these simplifying assumptions, this analysis provides, for the first time, preliminary estimates of potential impacts from the broad introduction or expansion of efficiency standards and building codes in these countries.

4.3 Energy Savings

The following two tables present preliminary estimates of electricity and primary energy savings from the introduction or expansion of efficiency standards and building codes in the selected countries. They are not definitive estimates because they rely on many assumptions. Reporting a range of estimates would have better communicated uncertainty but that is not the purpose here. Rather, the purpose is to report first-cut, preliminary figures.

Table 4-2, containing figures on electricity savings, indicates that efficiency standards and building codes could significantly reduce electricity consumption in the selected countries. Cumulative savings from 2000 to 2020 total 11 to 16 percent of electricity consumption. These savings are equivalent to between five and ten years of current (1995) annual electricity consumption in each country. The biggest savings come from standards on motors, lighting, HVAC equipment, refrigerators, air-conditioners and pumps.

Table 4-2 Electricity Savings from Efficiency Standards and Building Codes: 2000-20

		India	Indonesia	Philippines	Mexico	Brazil
Baseload Capacity Savings						
(GW)	2010	14	4	2.0	5	12
	2020	25	6	3.5	7	17
Cumulative Energy Savings: 2000-20 (TWh)						
Industrial	Motors	307	45	27	76	142
	Lighting	132	30	15	58	137
Commercial	Lighting	163	50	36	70	227
	HVAC	198	86	62	118	341
	Refrigeration	25	8	6	10	34
Residential	Refrigeration	173	65	27	40	87
	Air conditioning	105	53	19	47	51
	Fans	40	15	8	19	42
	Water heating	28	0	0	0	27
	Clothes washing	14	5	3	7	14
	Lighting	134	61	30	78	169
	Television	10	4	2	5	10
Agriculture	Pumps	330	0	0	21	28
Total		1,659	421	234	550	1,310
Total Savings as:						
Yrs of 1995 Consumption		6.3	9.6	9.2	5.0	5.2
% of 2000-20 Cons. w/o Standards		11%	16%	16%	12%	12%

Baseload capacity savings would also be significant, including 25 gigawatts (GW) in India and 17 GW in Brazil by the year 2020. Peak capacity savings, not estimated here for lack of data on the peak-coincidence of electricity consumption, would also be significant.

These figures are very sensitive to the assumed growth rate of energy consumption. They were calculated using a six percent annual rate of growth in electricity consumption in India, Indonesia and the Philippines and four percent in Mexico and Brazil. Increasing this rate of growth by 50 percent to nine percent in Asia and six percent in Latin America would increase baseload capacity and cumulative energy savings by 50 to 90 percent. Instead of saving five to ten years worth of current (1995) annual consumption over the 20-year period, standards would then save seven to 16 years worth. On a percentage basis, the savings would be about the same.

The next table provides estimates of fossil fuel savings. Most of these savings are associated with the reduced need for electricity generation. This is because most standards apply to products that are powered by electricity. However, standards also provide significant savings in the industrial and transportation sectors where products powered by fossil fuels experience increased energy efficiency.

Cumulative savings over the 20-year period amount to the equivalent of two to four years of current (1992) annual primary energy supply in the various countries.

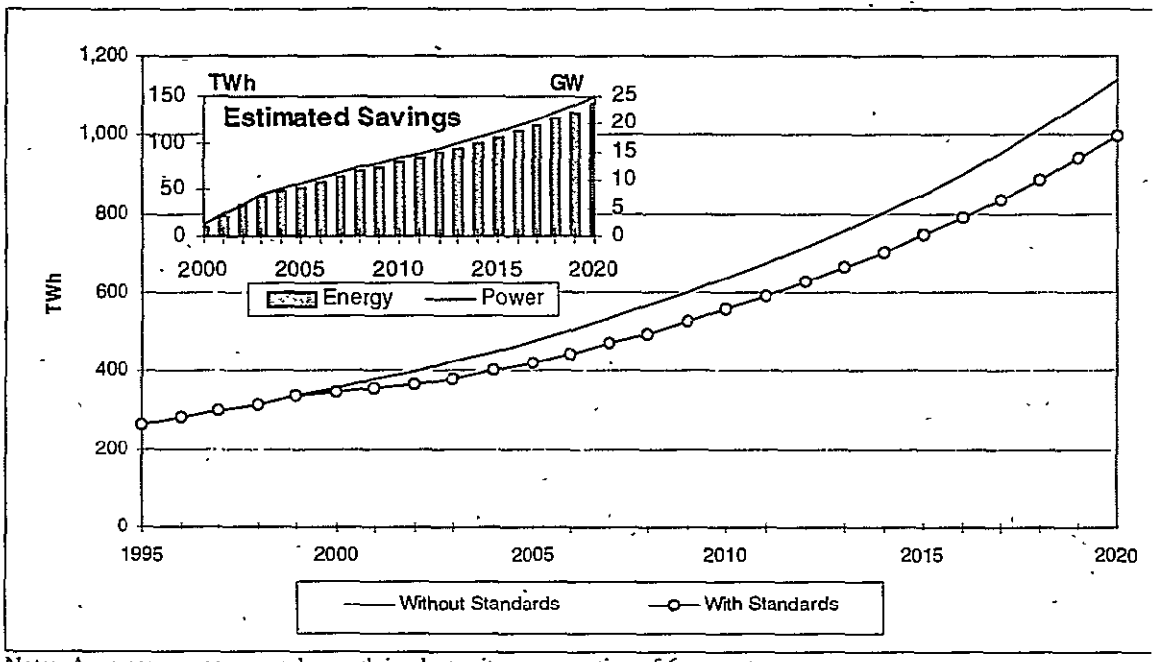
Table 4-3 Fossil Fuel Savings from Efficiency Standards and Building Codes: 2000-20

Source of Savings		India	Indonesia	Philippines	Mexico	Brazil
(Petajoules)						
Electricity	Coal	17,128	1,732	216	516	289
Generation	Oil	884	2,847	1,801	3,917	470
	Gas	246	189	0	794	31
Industrial	Coal	4,376	88	53	85	479
Sector	Oil	1,150	665	210	773	825
	Gas	547	525	0	929	139
Buildings	Coal	0	0	0	0	0
	Oil	0	0	0	697	504
	Gas	0	0	0	82	17
Agriculture	Oil	56	293	51	141	281
Transport	Oil	3,267	2,274	813	5,557	6,194
All Sectors	Coal	21,504	1,819	270	601	768
	Oil	5,356	6,079	2,874	11,085	8,274
	Gas	793	714	0	1,804	187
	Total	27,652	8,612	3,144	13,490	9,230
Total as Years of 1992						
Primary Energy Supply		3.1	3.4	3.6	2.5	2.1

Again, these savings were calculated using the baseline growth rates noted above. Using the higher growth rates would increase the cumulative savings by 50 to 90 percent. Instead of saving two to four years worth of current (1992) annual consumption over the 20-year period, standards and building codes would save three to six years worth.

The impact of standards and codes is shown in graphical form in the following figure. It shows total electricity consumption in India from 1995 to 2020, with and without efficiency standards and building codes, assuming a six percent average annual growth rate in electricity consumption. Similar impacts would occur in other countries.

Figure 4-1 Electricity Consumption in India and Associated Savings from Standards and Building Codes, 1995-2020



Note: Assumes average annual growth in electricity consumption of 6 percent.

4.4 Carbon Emission Reductions

The above energy savings would provide a host of environmental benefits, including reduced air pollution and greenhouse gas emissions, less water and toxic pollution and less land disturbance from energy production and transportation. A full accounting of all these impacts was not possible for this report. Instead, it estimates potential carbon emission reductions from efficiency standards and building codes. Carbon emissions are among the most significant environmental impacts from energy use. Other air emissions would be reduced by similar amounts as listed below.

Based on the above energy savings estimates and countries' average electricity generation fuel mixes, cumulative carbon emission reductions over the 20-year period would be significant, equivalent to between three and five years of current (1991) annual emissions from these countries. Most of these reductions would be associated with the reduced need for electricity generation, although direct carbon emission reductions in industry, buildings and transport would also be significant in some countries.

Table 4-4 Cumulative Carbon Emission Reductions due to Efficiency Standards and Building Codes: 2000-20

Source of Carbon	India	Indonesia	Philippines	Mexico	Brazil
(million metric tonnes)					
Electricity generation	431	102	42	103	17
Industry direct	135	23	6	31	30
Buildings direct	0	0	0	15	10
Agriculture	1	6	1	3	6
Transport	66	46	16	112	125
Total	633	176	65	264	188
Total as Years of 1991 Emissions	3.3	3.8	5.3	2.8	3.2

4.5 Export Market Impacts

Efficiency standards would benefit manufacturers of energy-efficient products around the world by expanding the global market for these products. Manufacturers in developed countries like the United States could exploit this expanded market in two ways: by selling energy-efficient technology to developing country manufacturers or by entering these markets directly. The latter could be achieved by establishing new manufacturing facilities in developing countries, entering into joint-ventures with in-country manufacturers or exporting products to these markets.

The figures in the following table provide some indication of the magnitude of these expanded markets. It shows estimated unit sales of energy-efficient products in the various countries in the year 2010, ten years after introduction of standards. Examples include over one million industrial motors, over 300 million lamps and associated lighting products, over one million electric pumps, 53 million refrigerators and over two million air-conditioners. These represent incremental sales of energy-efficient products that would be made possible by new efficiency standards.

Table 4-5 Sales of Energy-Efficient Products Covered by Standards in the Year 2010

Product	India	Indonesia	Philippines	Mexico	Brazil
Industrial Boilers	33	7	1	9	7
Industrial Motors	647	94	57	156	290
Lighting	106,355	40,984	21,744	55,914	131,492
Electric Pumps	1,212	0	0	75	100
Diesel Pumps	59	307	53	301	600
HVAC	19	8	6	11	30
Commercial Refrigeration	85	26	19	33	523
Residential Refrigerators	5,719	2,159	896	2,952	40,995
Air Conditioners	755	380	218	513	555
Fans	47,730	18,023	8,974	21,487	46,549
Water Heaters	1,131	0	0	0	875
Clothes washers	1,302	492	245	553	1,199
Televisions	8,054	3,041	1,514	3,626	7,855
Light Motor Vehicles	677	471	168	1,077	4,825

4.6 Economic Impacts of U.S. and Mexican Efficiency Standards

While this report does not estimate the economic impacts of efficiency standards in the selected countries, the following results from the U.S. and Mexico provide some indication of the impacts that would likely occur.

U.S. efficiency standards on household appliances are projected to generate $60 billion in net present value consumer benefits over the next 20 years. Standards on commercial and industrial equipment are expected to generate a further $72 billion in net present value benefits over the next 35 years.

Table 4-6 Consumer Economic Impacts from U.S. Efficiency Standards

Group of Standards	Net Benefit	Gross Benefit	Gross Cost
	(present value in 1990$ billions discounted at 7% real)		
NAECA Standards forecast to 2015	60.6	98.8	38.2
EPAct Standards forecast to 2030	72.0	94.0	22.0

Source: Lawrence Berkeley Laboratory.

In a similar fashion, Mexican refrigerator and room air-conditioner standards are projected to benefit almost all stakeholders in Mexico, including consumers, manufacturers and electric utilities. Only the government will have a net cost for implementing the standards. Total net benefits from the refrigerator and air-conditioner standards over 20 years are projected at a present value of $256 and $19 million, respectively.

Table 4-7 Economic Impacts of Mexican Refrigerator and Room Air-Conditioner Efficiency Standards

Stakeholder Group	Impact	Refrigerators	Room Air-Conditioners
		(present value over 20 years in $ millions)	
Consumers	Net Benefit	67	37
	Gross Benefit	138	67
	Gross Cost	71	30
Manufacturers	Net Cash Flow	156	1
	Incremental Income	244	44
	Incremental Cost	98	43
Utilities	Net Benefit	58	-20
	Avoided Costs	242	72
	Reduced Income	184	92
Government	Incremental Cost	0.4	0.033
Total	Net Benefit	256	19
	Gross Benefit	625	183
	Gross Cost	369	164

Source: Landa and Campero

5. Glossary of Acronyms

ACEEE	American Council for an Energy-Efficient Economy
AHAM	Association of Home Appliance Manufacturers (U.S.)
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute (U.S.)
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations (U.S.)
CGA	Canadian Gas Association
CIE	International Commission on Illumination
CSA	Canadian Standards Association
EPACT	Energy Policy Act (U.S.)
IEA	International Energy Agency
IEC	International Electro-technical Commission
IES	Illuminating Engineering Society of North America
ISO	International Organization for Standardization
JIS	Japanese Standards Institute
kcal	kilo-calorie (1,000 calories)
kJ	kilojoule (1,000 joules)
KS	Korean standard
ktoe	thousand tonnes oil equivalent
NRCan	Natural Resources Canada
pJ	Petajoule (10^{15} joules)

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